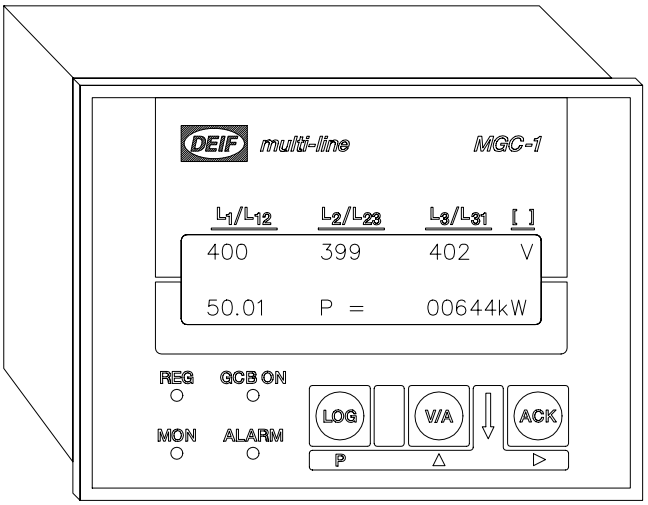
User's manual

Multi Generator Controller Type MGC-1

multi-line

4189340032H



- *Compact system in one unit*
  - *dynamic synchronisation*
  - *load sharing*
  - *generator protection*

- *3-phase AC_{RMS} measurements*
- *Calculation of complex AC values*
- *Easy operator programming in engineering units*
- *Reliable self-monitoring system*

CE

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List of contents

THIS MANUAL RELATES TO MGC-1 VERSION 1.4X (VERSIONS 1.40...1.49)

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1 Warnings, legal information and notes to CE-marking

This manual gives general guidelines on how to install and operate a gen-set using the product MGC-1. Installing and operating a gen-set implies generation of dangerous current and voltages, and therefore this should only be done by qualified personnel. DEIF takes no responsibility for operation or installation of gen-sets or other systems. If there is any doubt about how to install or operate the gen-set the company responsible for installation or operation must be contacted.

MGC-1 is CE-marked with respect to the EMC directive for residential, commercial and light industry plus industrial environment. This covers all environment types where MGC-1 normally can be used.

MGC-1 is CE-marked with respect to the low-voltage directive for up to 300 V phase to ground voltage, Installation category (Overvoltage category) III and pollution degree 2. 300 V phase to ground voltage corresponds to 480 V phase to phase voltage in 4-wire networks and 500 V phase to phase voltage in 3-wire networks.

The connections for current transformers (terminal 40 to 45) are special high power plugable connections. Be sure to short circuit current transformers before disconnecting the current transformers by unplugging these terminals.

The package contains the following items:

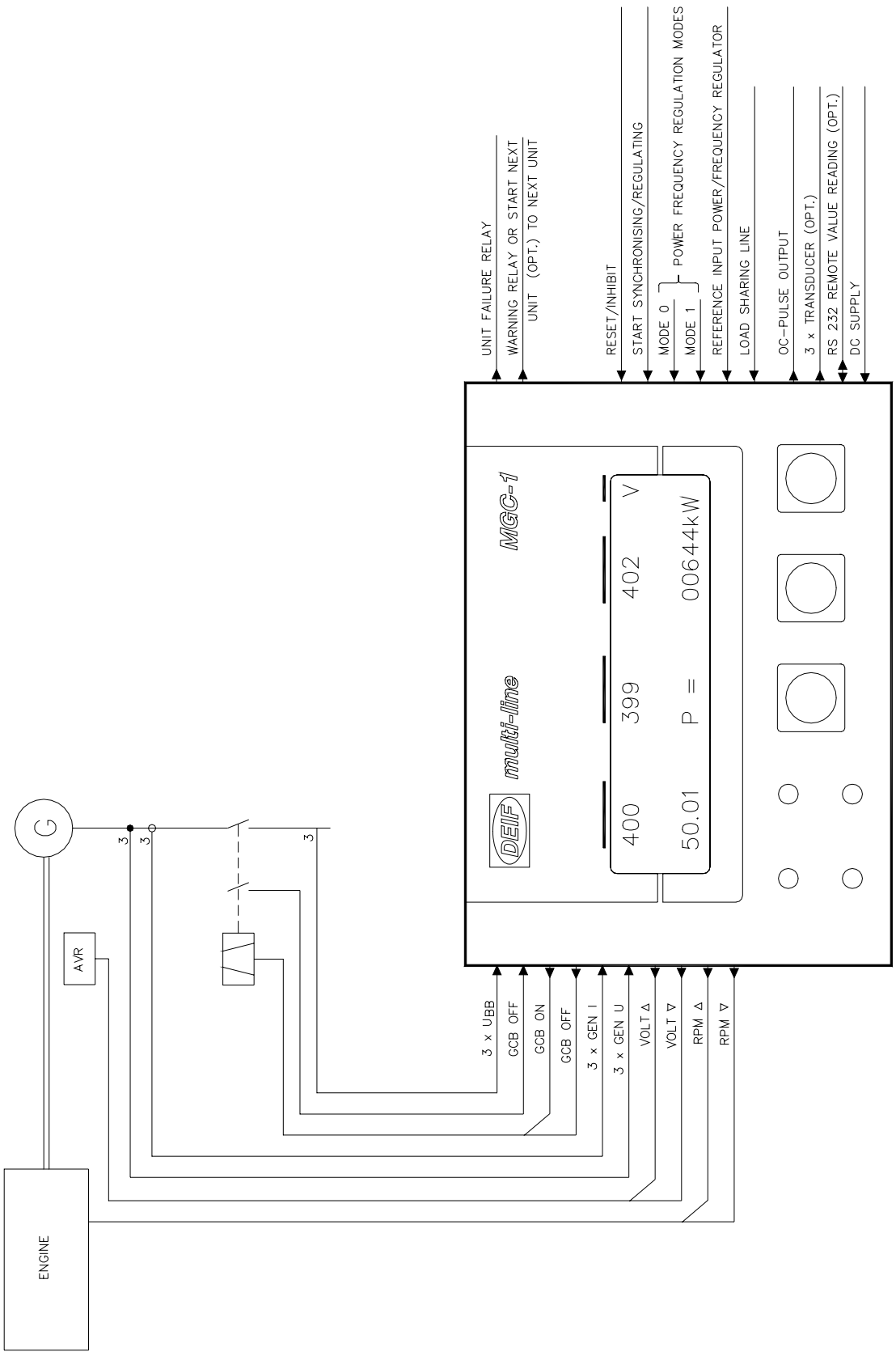
- multi-line MGC-1 unit
- This user manual
- If serial communication option is included a special user manual for serial communication.

The MGC-1 unit should be fitted with fixing clamps on the side for mounting in the switchboard and the plugable connections on the rear should all be fitted with connectors for mounting the wiring.

2 Applications and functionality summary

The MGC-1 generator controller is a microprocessor-based control unit containing all necessary functions for the control of a synchronous or an asynchronous generator running in island mode or running in parallel with the mains. The MGC-1 can synchronise the generator to the mains and after synchronisation carry out all generator protective functions and control the generator. MGC-1 is a flexible and menu-programmed unit, enabling the user easily to adapt the unit to the generator and to the application in question. Programming procedures are password protected. MGC-1 contains all necessary measuring circuits and presents all values on a LC display. Messages are presented in clear text, all measuring values in engineering units.

The MGC-1 carries out a cyclical self-test, displaying error messages, should any errors occur.



A principle diagram of connecting MGC-1 is shown above.

2.1 Synchronisation

MGC-1 can do a dynamic synchronisation, where the generator frequency is controlled to be slightly higher than the busbar frequency, when the breaker closes. This ensures that the generator will start to take load in the moment the generator breaker is closed. The frequency difference between generator and busbar in the moment of synchronisation (called slip frequency) can be programmed. Breaker time can be adjusted to ensure breaker closure at the exact point of synchronisation. MGC-1 can control the voltage under synchronisation if necessary.

During synchronisation MGC-1 is supervising the frequency of the generator voltage to make sure that the gen-set is not unstable due to a cold fuel/gen-set or an uneven fuel-supply. The two frequencies must be within the accepted slip-frequency in 200 msec before synchronisation.

MGC-1 will synchronise the generator to the mains, when all below conditions are fulfilled:

- A control order is given by setting the input "start synchronising/regulating" or by the serial channel
- Feedback signal from breaker "GCB open" is present
- Busbar voltage is present
- Generator voltage is present

The frequency regulator in the synchroniser will start when the generator voltage and the busbar voltage is over 50% of nominal voltage (voltage transformer secondary setting). The voltage regulator in the synchroniser will start when the frequency is within 90% of nominal frequency.

MGC-1 will close the breaker without carrying out a synchronisation, when all below conditions are fulfilled:

- Display setting "Black busbar op." is ON
- A control order is given by setting the input "start synchronising/regulating" or by the serial channel
- Feedback signal from breaker "GCB open" is present
- Busbar voltage is not present (black bus bar)
- Generator voltage is present

2.2 Power or frequency control (load sharing)

The MGC-1 will control the power or the frequency in 4 different modes, when the following conditions are fulfilled.

- A control order is given by setting the input "start synchronising/regulating" or by the serial channel
- Feedback signal from breaker "GCB open" is not present

The 4 different control modes are selected either through the input "mode 0" and "mode 1" or through the serial channel. Status "0" in the below table means input unconnected. Status "1" means input is connected.

The frequency control mode and the power control mode is mainly usable for power management together with a PLC, where the PLC will control the mode inputs and the

reference to the controller. This gives a very flexible power management that can do unequal load sharing among generators, "base load + topping up" systems or systems with changing frequency control masters.

Speed droop or power summation control modes are mainly used in systems where the load-sharing principle is more simple, and the MGC-1 can therefore do the power management with no external control.

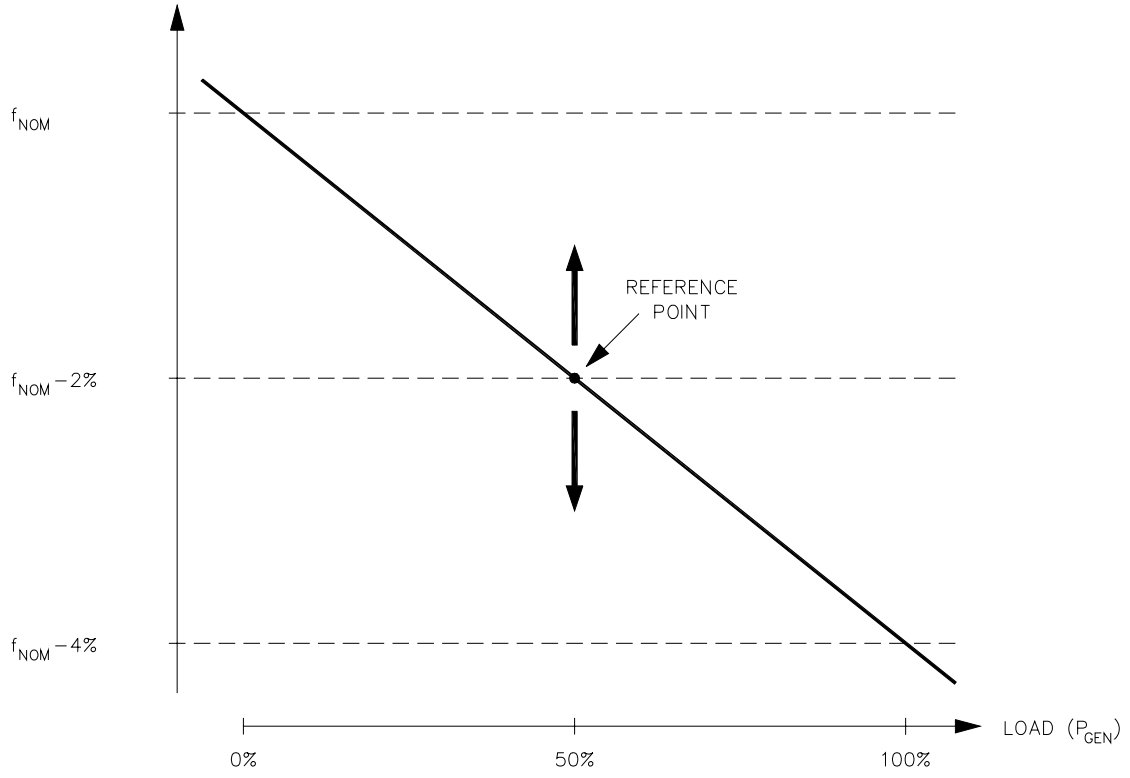
Mode	Mode 1	Mode 0
Frequency control	0	0
Speed droop	0	1
Power summation control	1	0
Power control	1	1

Frequency control mode

In the frequency control mode the frequency is controlled to a preset nominal frequency. A display setting decides whether this nominal frequency can be set via the 0...20mA analog input "value reference", via a display setting or via the serial channel. The range of the value reference input can be set in the display.

Speed droop mode

In the speed droop mode the frequency is controlled according to the generated power. The speed droop will be active for power control mode as well, but in speed droop mode this is the only controlling parameter. Speed droop parameters can be set in the display.



The graph shown above is controlled by three parameters. f_{NOM} the nominal power and the speed droop (set as % of f_{NOM}, here 4%). If the frequency controller uses an external source the graph will also change with the external source. E.g. if the analog set-points are set to 0mA ≈ 45Hz and 20mA ≈ 55Hz, the f_{NOM} at the y-axis is 47Hz at 4mA. All other regulator

parameters for the frequency regulation part of the speed droop mode are similar to the setting underfrequency mode and are adjusted with the setting underfrequency control.

Power summation mode

In the power summation mode the analog input/output "load share" is connected together on all MGC-1's on the generators where load must be shared. The load share line will distribute information about generated power between the generators so that load will be equally shared among the connected gen-sets. All connected MGC-1's will share load between their associated generators, so that these produce the same percentage of their nominal power. It is possible to set the weighing between frequency control and load-sharing in the display in power summation mode, so that the generators will do a distributed frequency control together with the load sharing. The nominal frequency setting and other regulator parameters for the frequency regulation part of power summation mode is similar to the settings under frequency control mode and is adjusted with the settings under frequency control.

The analog input/output "load share" is a 0...5VDC analog line, where 4V corresponds to 100% nominal power from all connected generators.

Each of the connected generators will contribute to the voltage on the load sharing line with the following voltage:

$$V_{out} = 4V \cdot \frac{P_{gen}}{P_{nom}}$$

The voltage on the load share line will be the mean of the voltage from all connected MGC-1. When the feedback signal from the breaker "GCB open" is present the load sharing line is in high impedance state, so the load sharing of the connected generators is not affected by the stopped gen-set. The MGC-1 feeds signal to the load sharing line in all 4 modes when the breaker is closed and "start reg" input control signal is ON so the load-sharing line can be used in applications where generator controllers are used in different modes. The voltage on the load share line has reference to terminal 4, generator neutral.

Up to 6 generators can be connected in parallel on the load sharing line when the generators are equally sized. More generators mean that the load sharing will be more inaccurate. As a general guideline the load sharing line will be to inaccurate if a generator contributes with less than 15% of the total power in the plant.

It is possible to connect an external 0...4VDC voltage generator to the load sharing line to affect the load sharing. This connection can be used to synchronise a group of generators to mains or to regulate mains power transport in a group of generators. The external 0...4V DC voltage generator must be connected through a 5Kohm resistor to match the impedance to the input impedance of the load sharing line in MGC-1.

Power control mode

In the power control mode the power is controlled to a preset nominal power. A display setting decides whether this nominal power can be set via the 0...20mA analog input "value reference", via a display setting or via the serial channel. The range of the value reference input can be set in the display.

2.3 Ramp down and opening of breaker

If the function "Stop sequence" is selected (ON), removal of the input "Start sync/reg." will cause the MGC-1 to disconnect from the load sharing line (if running in power summation mode) and to ramp down the generator active load. When the load reaches 10% of nominal power, a relay output can be chosen to open the generator breaker.

2.4 Generator protective functions

All generator protective functions are active when they are selected and the reset/inhibit input is not present. The generator protective functions is not affected by GCB position or the control input "start synchronising/regulating"

Overvoltage (U>) in 2 steps

Undervoltage (U<) in 2 steps

Asymmetrical voltage

Overfrequency (f>) in 2 steps

Underfrequency (f<) in 2 steps

Overcurrent (I>) in 2 steps

Overload (P>)

Asymmetrical load

Reverse power (-P>)

Loss of excitation (Q >) with separate set-points for capacitive and inductive reactive power

Single phased busbar overvoltage (U>)

Single phased busbar undervoltage (U<)

Busbar overfrequency (f>)

Busbar underfrequency (f<)

For marine installations it is demanded from the classification societies that the GCB is equipped with an undervoltage coil.

2.5 Trip and warning outputs

3 potential free contacts each can be programmed to react on a selection of the generator protective functions. This makes it very easy to program a unit that exactly matches the requirements to trip and warning outputs.

2.6 Synchronisation and governor outputs

Synchronisation relay (Breaker ON) that can be programmed at either pulse or holding relay.

2 sets of governor up/down relays for speed governor and voltage regulator. Voltage regulation is optional and can be deactivated from display setting. The governor up down signals can be replaced by analog outputs to electronic governor systems (option B).

2.7 Status indications and control

Reset/inhibit input. When this input is activated all alarms will be acknowledged. If the input is kept activated all alarms except generator overvoltage and generator overfrequency are inhibited.

GCB open input. Status indication from GCB. Used to control synchronisation and regulation system.

Start synchronising/regulating input. Used to start synchronisation and regulation system.

Mode 0 and Mode 1 input. Used to set power regulation mode as described in paragraph 1.2.

Load sharing analog input/output. Used to do equal load sharing in power summation mode.

Value reference analog input. Used to set-point for regulators in frequency or power control mode.

Tripping and condition indication in clear text on LC display

AC values on LC display
4 LEDs: MON , ALARM , "REG " and "GCB ON"

3 Options

Option A: Voltage control/Cos control/VAR control
The voltage, Cos or the reactive power is controlled to a preset nominal value. This can be set via the display or via the serial channel. The controlling parameters can be set via the display.

Option B: Analog Speed/AVR control
- analog signal +/-5V replacing governor relay outputs
B1: Analog speed governor output
B2: Analog AVR
B3: Analog speed governor and AVR

Option C: Analog transducer outputs (multitransducer)
-3 x (0)4...20mA or -20...0...20mA output representing selected electrical values. Each output can be programmed to represent the desired measuring value, output range and output type.

Option D: Remote value reading
D1: RS 232 remote value reading of all values measured by MGC-1. Siemens 3964, RK512 with standard telegram
D2: RS 485 remote value reading of all values measured by MGC-1. Modbus RTU interface
D4: RS 485 remote control and value reading of all values measured by MGC-1. Modbus RTU interface

Other serial communication standards on request

Option E: $d\varphi$ /dt protection (vector jump)

Option F: df/dt protection (frequency deviation or rate of change of frequency)

Option H: Power maximum relay output
- Relay output to start and stop next generating set on power demand.

Option K0: 12V DC Power supply
Option K1: 48V DC Power supply
Option K2: 110V DC Power supply
Option K3: 220V DC Power supply

Option L: Front: IP54. The front of the unit is sealed to IP54 (normally IP52).

4 Operation of display, pushbuttons and LEDs

MGC-1 can be operated in two different modes: "normal mode" and "parameter entering mode". Normal mode is used to display measuring values and to display and acknowledge alarms when the unit is installed and the gen-set is running. Parameter entering mode is used to program the unit to the desired functionality.

4.1 LC Display

MGC-1 has a 2-line green LC display containing the following information:

In normal mode the upper line reads voltage or current and the lower line reads frequency and the scrolling menu of other measured values and alarm messages. The alarm stack is 4 alarms deep, which means that the MGC-1 will keep the first 4 alarms in memory until they are acknowledged manually or automatically. If more than 4 alarms occur at one time the outputs will operate correctly as response to the alarms but the alarms will not be shown in display.

List of alarms

Overvolt.1	The first limit for overvoltage is exceeded.
Overvolt.2	The second limit for overvoltage is exceeded.
Und.volt.1	The first limit for undervoltage is exceeded.
Und.volt.2	The second limit for undervoltage is exceeded.
Asymmetry	There has been asymmetry on the generator voltage
Overfreq.1	The first limit for overfrequency is exceeded.
Overfreq.2	The second limit for overfrequency is exceeded.
Und.freq.1	The first limit for underfrequency is exceeded.

Und.freq.2	The second limit for underfrequency is exceeded.
Phase jmp	A phasejump has occurred.
Fault df	A df/dt has occurred.
Ov.curr. 1	The first limit for overcurrent is exceeded.
Ov.curr. 2	The second limit for overcurrent is exceeded.
Overload	The generator is overloaded.
Rev. Power	Reverse power. The generator receives power.
Unbalance	The load on the three phases is in unbalance.
React.pow-	The generator produces too much capacitive power.
React.pow+	The generator produces too much inductive power.
U> Busbar	The busbar voltages are too low.
U< Busbar	The busbar voltages are too high.
f> Busbar	The busbar frequency is too low.
F< Busbar	The busbar frequency is too high.

In parameter entering mode both lines show information relating to the parameter that is adjusted.

The LC display contrast/brightness can be adjusted by the potentiometer placed on the left side of the MGC-1. The adjustment is accessible without opening the unit. The display is illuminated for easy reading in dark environments.

4.2 LEDs

MGC-1 has 4 LEDs on the front showing different operating information

The yellow LED with the name REG is indicating that MGC-1 is either synchronising or regulating power when the light is steady.

The yellow LED with the name GCB ON is indicating that the controlled breaker is closed when the light is steady.

The green LED with the name MON (monitoring) indicates that MGC-1 is functional when the light is steady, and indicates the unit is in parameter entering mode, when the light is flashing.

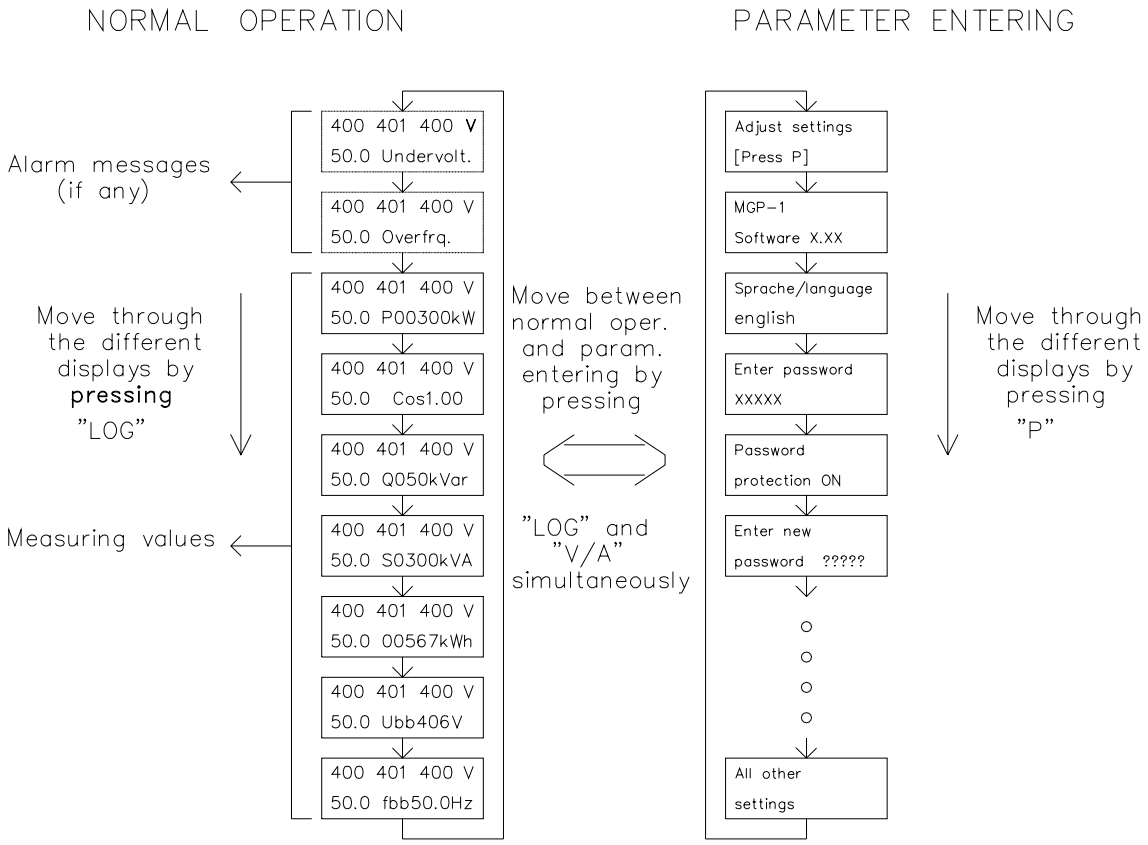
The red LED with the name ALARM indicates that MGC-1 has an alarm in the memory that has not been acknowledged yet. When all alarms are acknowledged one by one, the LED changes from flashing to steady light if the alarm is still present or switched off if none of the alarms are present.

4.3 Pushbuttons

MGC-1 is operated through the 3 pushbuttons below the display. The 3 pushbuttons has different meanings in the two operating modes: "normal operation" and "parameter entering mode". The functional names of the 3 pushbuttons in normal mode are shown inside the pushbuttons, and the functional names of the 3 pushbuttons in parameter entering mode is shown below the pushbuttons.

Pressing the two pushbuttons “V/A” and “ACK” simultaneously does a change between the two operating modes. If the unit is left in parameter entering mode, it will automatically

change back to normal mode after 2 minutes with no activity on the pushbuttons. An overview of the operating principle of the display and pushbuttons in the two operating modes is shown in the figure below:



"LOG" (Normal operation)

Scrolling through following information shown on the second line in the display.

- alarm message(s)
- Reading of active power transport
- Reading of Cos
- Reading of reactive power transport
- Reading of apparent power
- Reading of measured energy transport
- Reading of busbar voltage
- Reading of busbar frequency

"V/A" (Normal operation)

Scrolling through phase to phase voltages, phase to neutral voltages or currents shown on the first line of the display.

"ACK" (Normal operation)

Acknowledge of alarms. All alarms will be reset by a 3-second push. Resetting alarms one by one is not possible.

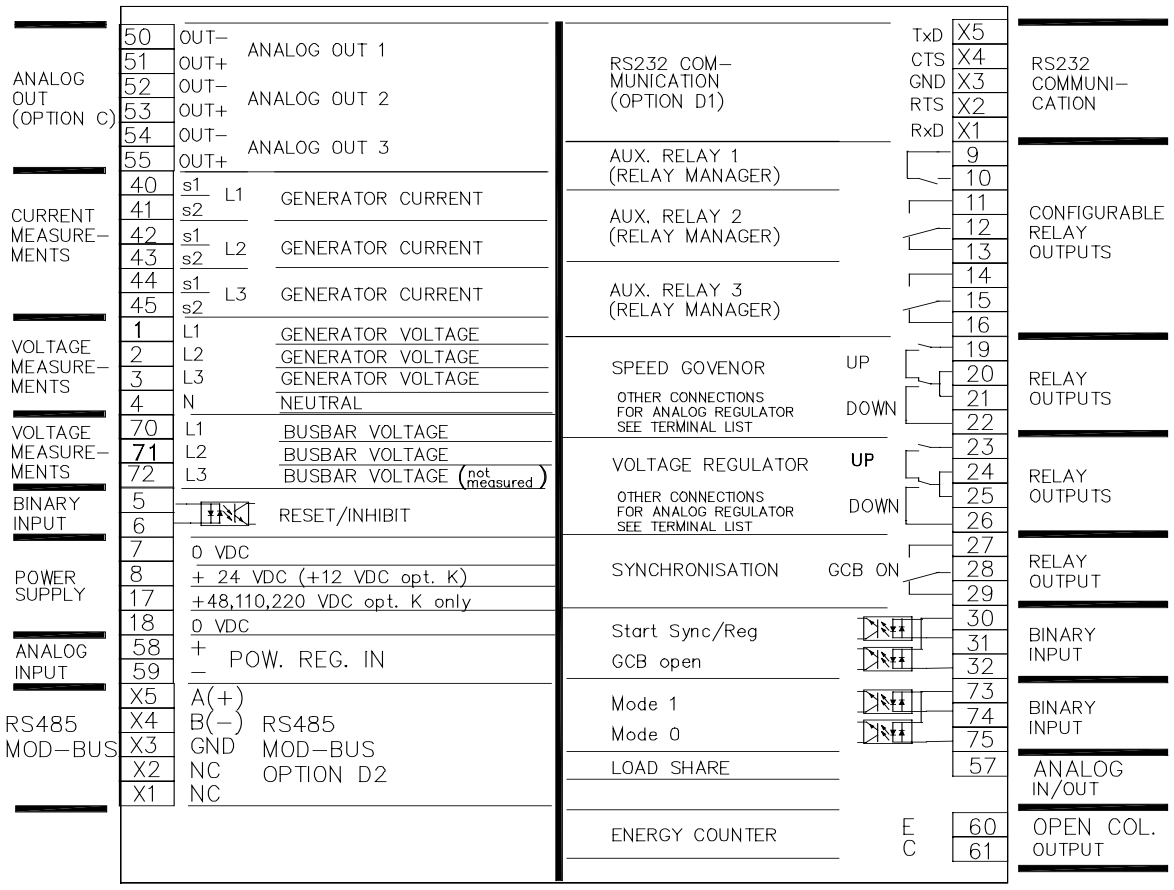
"P" (Parameter entering)
Scrolling through parameters that can be adjusted. Pressing the button will cause the display to jump to the next parameter that can be adjusted. When a value has been adjusted, pressing the button "P" programs the value that has been adjusted into the memory. This means that the button "P" must be pressed twice to jump to next parameter after a parameter has been adjusted.

"▲" (Parameter entering)
Pressing the button will make the number underlined by the blinking cursor to increase by 1 (within allowed limits of the parameter).

"▶" (Parameter entering)
Pressing the button will scroll through the different positions in the number that is adjusted. If the parameter that is adjusted is not a number, but instead a choice between different possibilities (e.g. "yes" or "no"), pressing "▶" will scroll through the different possible settings.

5 Terminal list

The figure shows an overview of the terminals. Further explanations on the next pages.

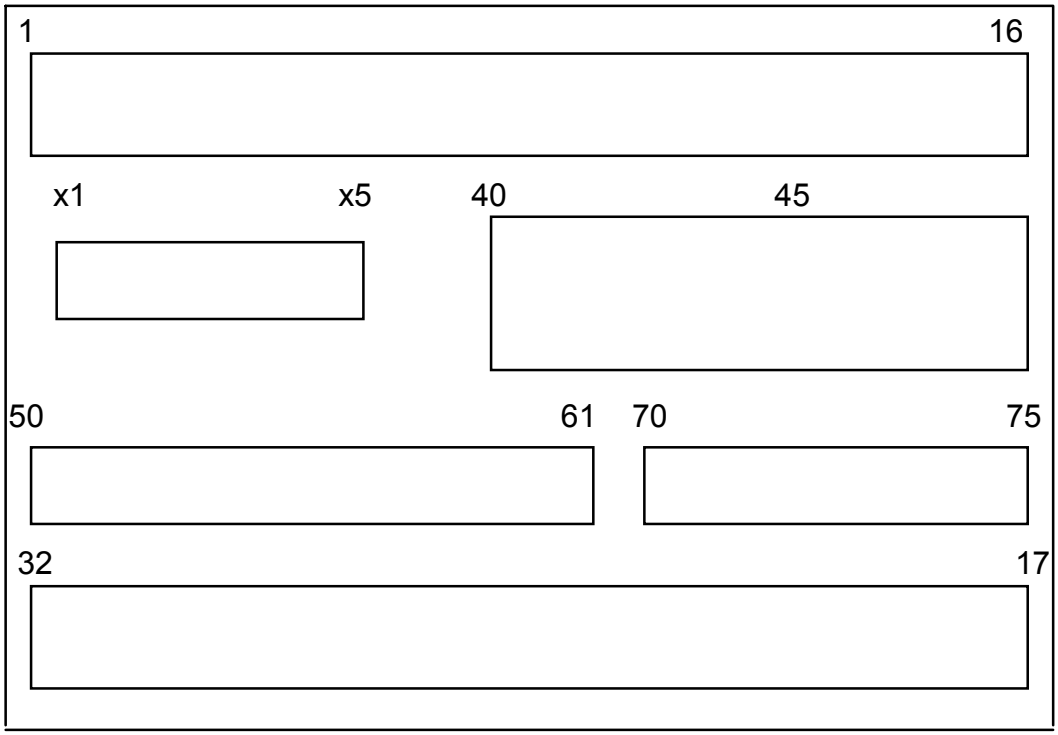


In the terminal list below, the abbreviations **CC = Closed contact, OC = Open contact, NO = Normally open, NC = Normally closed** will be used.

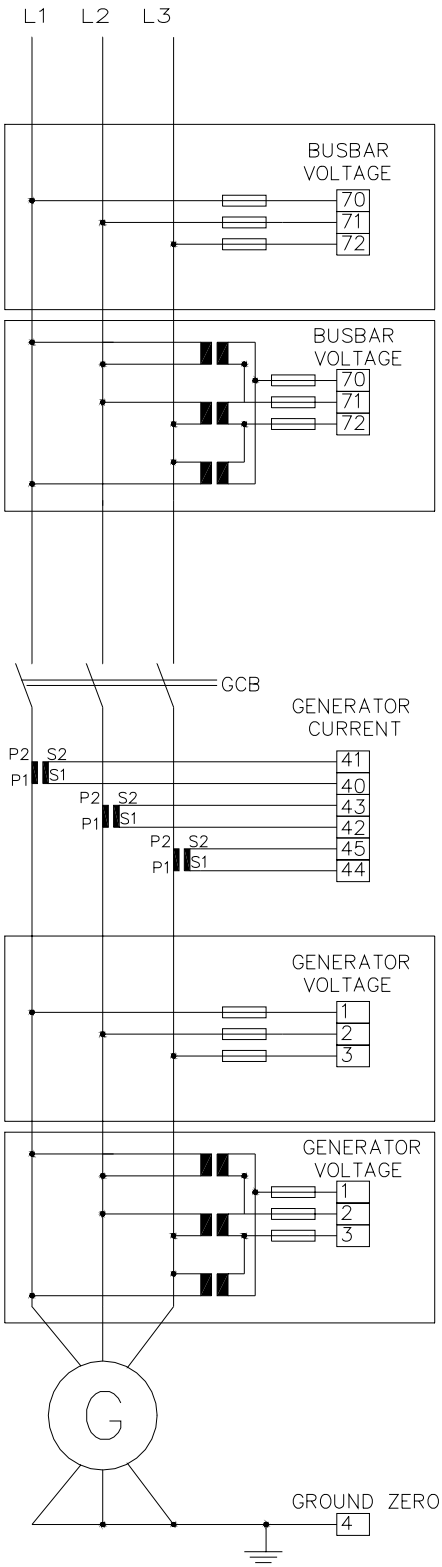
Terminal no.	In/Out	I/O Type	Signal name	Description
1 2 3 4	L1 L2 L3 Neutral	AC V input	Generator voltage	3-phase generator voltage with or without neutral, 100/110 or 250...450 VAC. If Neutral is connected to generator it should also be connected to earth with a short lead as close to the MGC-1 as possible. If Neutral is not connected to generator (3-wire system) Neutral on all MGC-1's must be connected.
5 6	Com In	Binary in	Reset/inhibit	Considered ON (CC) if input voltage between input terminal and common (- / 0) is 18...250 VDC or VAC.
7 8	0 +	Supp.	Supp.	Power supply standard 24 VDC, or option K (12 VDC supply)
9 10	Com NO	Relay output	Relay 1 (Unit failure)	Function can be set from display
11 12 13	NO Com NC	Relay output	Relay 2	Function can be set from display
14 15 16	NO Com NC	Relay output	Relay 3	Function can be set from display
17 18	+ 0	Supp.	Supply	Power supply option K (48 VDC, 110 VDC or 220 VDC supply)
19 20 21 22	UP Com Com DOWN	Governor Relay output	SG UP SG DOWN	If Option B1 or B3 is ordered these connections are exchanged with the analog regulator outputs shown below.
19 22	O U_{OUT}	Analog regulator	Governor output	Only if Option B1 or B3 is ordered
23 24 25 26	UP Com Com DOWN	Volt reg. Relay output	AVR UP AVR DOWN	If Option B2 or B3 is ordered these connections are exchanged with the analog regulator outputs shown below.
23 26	O U_{OUT}	Analog regulator	Voltage regulator output	Only if Option B2 or B3 is ordered
27 28 29	NO Com NC	Relay-output	GCB ON	Breaker closure output
30 31 32	Com	Binary input	Common Start sync/load GCB-open	Voltage between 30 and 31/31< 15 VDC/VAC = OFF, voltage between 30 and 31/32 >18 VDC/VAC = ON

40 41	S1 S2	AC I input	Generator current Phase L1	/1or /5 A current transformer input
42 43	S1 S2	AC I input	Generator current Phase L2	/1or /5 A current transformer input
44 45	S1 S2	AC I input	Generator current Phase L3	/1or /5 A current transformer input
50 51	- +	0/4..20 - 20..20mA	Analog output 1	Function and scaling can be set from display (Option C)
52 53	- +	0/4..20 - 20..20mA	Analog output 2	Function and scaling can be set from display (Option C)
54 55	- +	0/4..20 - 20..20mA	Analog output 3	Function and scaling can be set from display (Option C)
57		0...5V	Load sharing line	Only active in power summation mode
58 59	- +	0...20mA	Controller reference	Only active in power control mode or frequency control mode
60 61	E C	Open collector	Energy pulse out	Scaling can be set from display
70 71 72	L1 L2 L3	ACV input	Busbar voltage	3-phase busbar voltage without neutral, 100/110 or 250...450 VAC. L3 is not measured, but it must be connected for correct measurement of L1 and L2.
73 74 75	Com	Binary input	Common Mode 1 Mode 0	
X1 X2 X3 X4 X5		RxD RTS GND CTS TxD	Serial single-drop communication	Serial comm. RS 232. Must be connected through shielded twisted pair cable. RxD and TxD in one pair and RTS and CTS in other pair. Shield must only be connected to ground on one end of the cable, preferably the opposite end of the MGC-1 unit.
X1 X2 X3 X4 X5		NC NC GND B(-) A(+)	Serial multi-drop communication	Serial communication RS485 Modbus RTU. Must be connected through shielded twisted pair cable.

Terminal strip, rear view of MGC-1:



5.1 AC inputs



When ordering a MGC-1 the correct range of AC-inputs must be specified. It is possible to set current and voltage trafo specifications in the display.

NOTE:
Fuse in all AC voltage connections: Max. 2A slow-blow.

Direct voltage measurement. Max. 450 VAC.

Indirect voltage measurement. Generator voltage > 450 VAC.

The size of current transformer must be selected in such a manner, that there, by full generator load, runs min. 40% of nominal current on transformer secondary side. If not, non-correct functions may appear.

NOTE:
Fuse in all AC voltage connections: Max. 2A slow-blow.

Direct voltage measurement. Max. 450 VAC.

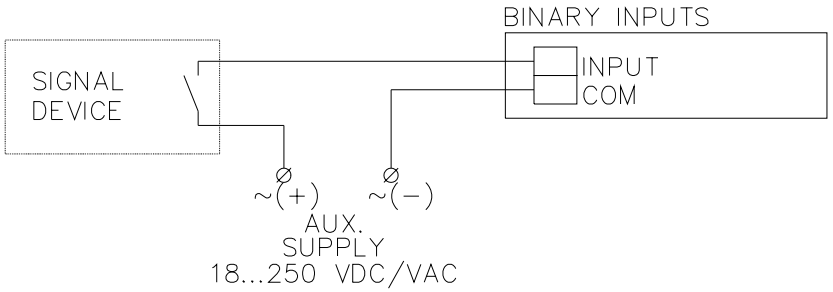
Indirect voltage measurement. Generator voltage > 450 VAC.

MGC-1 can be connected to both 3 and 4 wire networks. If the unit is connected to a 4-wire network, Neutral should be connected to ground with a short wire as close as possible to MGC-1. If Neutral is not connected to generator (3 wire system) Neutral on all MGC-1's in the plant must be interconnected.

5.2 Binary input (Reset/inhibit)

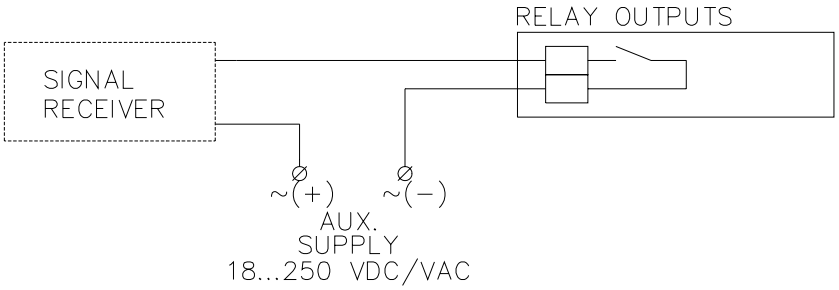
The binary input is a made to accept a very wide range of input voltages. This makes it possible to use a different power source than the power supply to the input.

Attention: When 12 VDC supply option is ordered, the input range is changed to 6...40 VDC/VAC to allow use of the power supply as aux. supply to binary inputs.



Internal input resistance: 68 k

5.3 Relay outputs

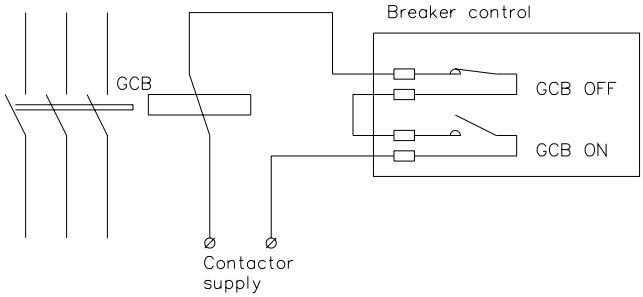


Contact material AgCdO

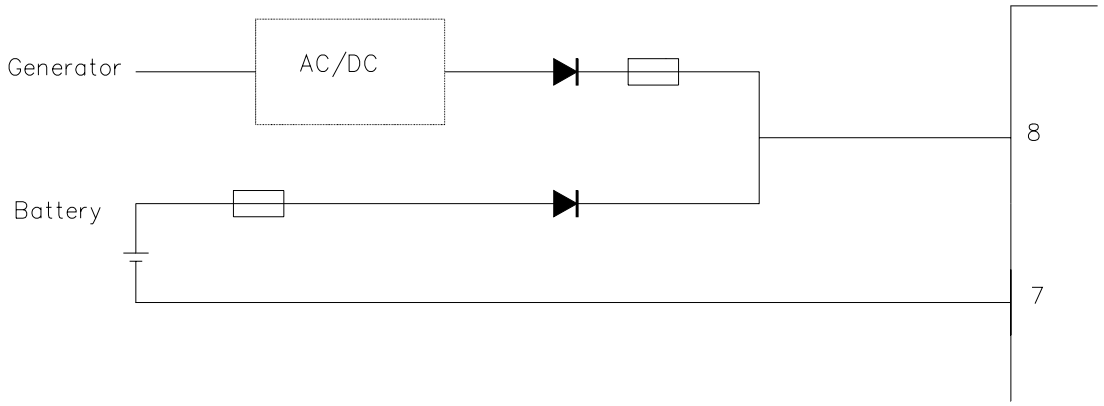
Nominal load 8 A, maximum load 10A
Nominal voltage 250VAC, maximum switch voltage 380VAC
Maximum power switching 2.000 VA @ 250VAC (Resistive load)
Lifetime @ resistive load 220VAC/8A, 100.000 operations

5.4 Connection of contactor as circuit breaker

This diagram shows how to connect MGC-1 when a contactor is used as circuit breaker. MGC-1 must be programmed to give a steady ON signal instead of a breaker on pulse, see synchronisation settings in paragraph 9.7. The GCB ON relay will go ON at synchronisation and hold the ON signal until the GCB OFF relay breaks the circuit.



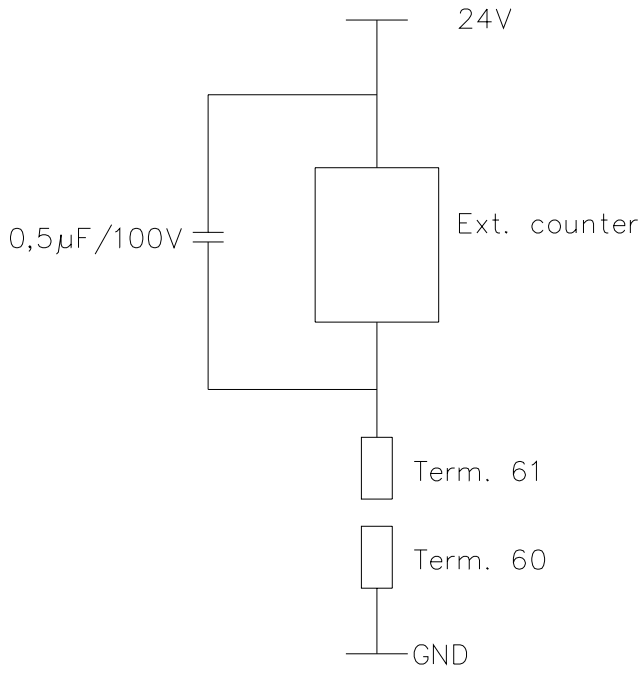
5.5 Supply circuit



Example of supply circuit.

For marine installations the classification societies (GL only) require that the unit can be supplied from both the generator protected and from a second source. It is also demanded to use an external fuse. A 2A fuse is recommended.

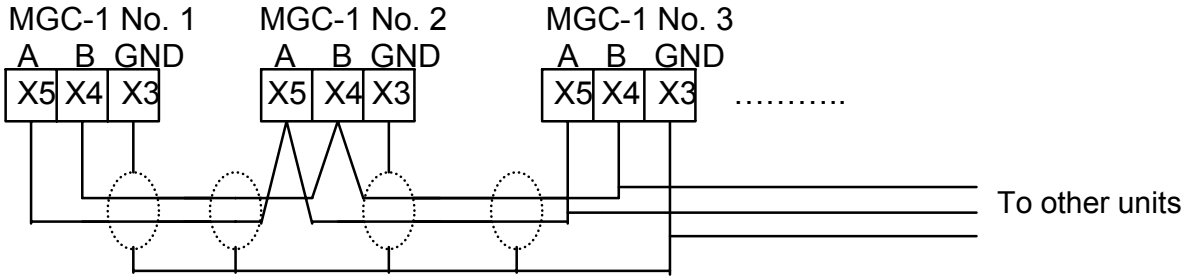
5.6 External counter



A 0.5µF (≥100V) capacitor should be connected in parallel with the energy counter.

5.7 RS485 multidrop Modbus

Shielded twisted pair cable (min. 0.5 mm^2) must be used.



Terminals X1 and X2: Do not use.

5.8 Mounting instruction

If option L is ordered the unit must be mounted carefully. The edge of the hole in the switchboard must be smeared with a sealing compound. This is also to be done with the bezel of the unit.

6 Commissioning

This paragraph gives general guidelines on how to do commissioning to a gen-set using the product MGC-1. Installing and operating a gen-set implies generation of dangerous current and voltages, and therefore this should only be done by qualified personnel. DEIF takes no responsibility for operation or installation of gen-sets or other systems. If there is any doubt about how to install or operate the gen-set the company responsible for installation or operation must be contacted.

Before commissioning: Check phases for correct voltage and correct rotary field. Emergency stop must be functional.

Warning: Missing or incorrect voltage and other input fails may lead to malfunction and damage to the unit.

For further explanations regarding setting the different parameters and their functions: Refer to paragraph 9 "programming parameters".

1. De-mount the GCB-ON output signal so the MGC-1 can not close the controlled breaker. Connect power supply

2. Push the buttons "V/A" and "ACK" simultaneously to swap between normal operation mode and parameter setting mode. Follow the instructions below to change any parameter needed. Push the buttons "V/A" and "ACK" again to return to normal operation mode.

3. Program gen-set parameters like nominal power and trafo specifications. Gen-set parameters are explained in paragraph 9.4 and 9.6.

4. Check all measured voltages and currents in the display by pressing the "V/A" button and thereby scrolling through all measurements. Check measured frequency in the display. Check measured power in the display by pressing the "LOG" button until measured power appears in the display. If some measured values are not correct, check generator current and voltage connections for correct current direction and rotary field.

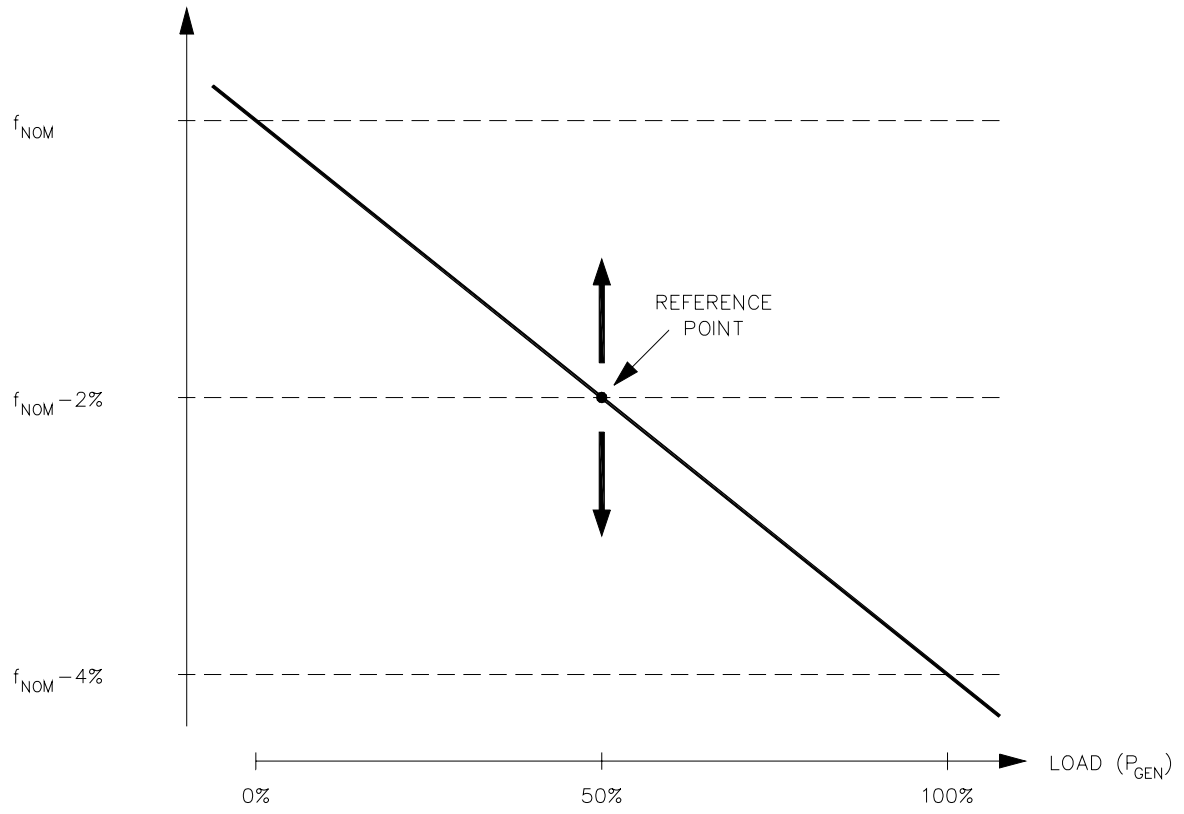
5. Set each of the desired protection types ON and adjust the parameters corresponding to the protection functions. See paragraph 9.11 to 9.24.

6. Set which output relays must react on the protection functions and how relay and display must react on tripping from the protection functions. See paragraph 9.25 and 9.26.

7. Check each of the selected generator protection functions by manually controlling the gen-set to a value 5% under the set-point, and it is controlled that no tripping of outputs occurs. Then the gen-set is controlled to a value 5% over the set point, and it is checked that the tripping occurs at the specified delay time. Controlling the current without generating power can be done by short-circuiting the generator, and start **without** Automatic Voltage Regulator (AVR). Then raise generator current step-by-step from zero to desired generator current by raising excitation voltage with the AVR. If it is impracticable to check the protection function at the programmed set-point, it is possible to program a protection limit that is more practical under commissioning. Remember to set MGC-1 back to the correct set-point after commissioning. Accurate control of fast responding relaying functions or relays implying dynamic response of voltage or frequency like df/dt or vector-jump will require special trained personnel and advanced current and voltage generation equipment. Please contact DEIF for assistance in commissioning relaying equipment.

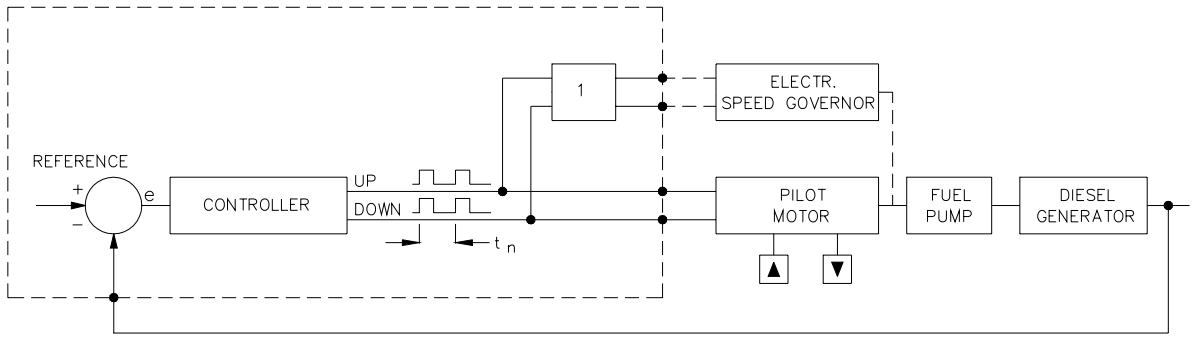
8. Set each of the desired control and synchronisation functions ON and adjust the corresponding parameters, see paragraph 9.7 to 9.10.

Both the frequency and power controllers are only able to operate if their corresponding speed governors have an available speed droop mode. The DGU's control the frequency and load by changing the reference point to the speed governor in either upwards or downwards direction (frequency wise). To align minor frequency offsets in the speed governor sensors a speed droop in the governor is necessary for stable operation. The speed droop range is recommended to be set as at least 4% of the nominal frequency (f_{NOM}) as shown in the figure below.



A smaller speed droop range than the recommended 4%, may result in a fast (may be too fast) dynamic control loop and thus an unstable power plant. A larger speed droop range than the recommended 4%, may result in a slow (may be too slow) dynamic control loop.

Each frequency and power controller have 3 or 4 different programmable set-points for mechanical output regulators or 3 programmable set-points for electronic output regulators. See paragraph 9.7 to 9.10 for explanation on the different set-points. The different regulator outputs are illustrated below for the speed governor output. The output system for the voltage regulator is similar to the illustration.



When adjusting the systems dynamic response, it is highly recommended to only adjust one type of set-point at a time, note the change of system performance and thereafter plan next change of setting. It is a good help in finding the best system performance to note the various test-settings together with a description of the system performance achieved at the various settings.

If a regulator has a too slow response, please try to increase the gain of the regulator, similar try to decrease the gain if the response is too fast.

For electronic output regulators (optional) the integrator reset time should be set to a value 10 times higher than the derivate time for the regulator as a starting point.

A regulation system for a generating plant can be designed in many different ways depending on the desired response from the generating system and the characteristics from the generators in the system. On the speed governor output each connected generator can be regulated to either frequency control or power control. On the voltage regulator, voltage, power factor or generator voltage can be regulated. Be careful to design a generator control system where all regulators controlling the connected generators try to regulate to the same system performance, e.g. two frequency controllers set to different nominal frequencies will not work properly together. Refer to application note "standard operating principles with *multi-line* MGC-1" for examples on building regulator systems to various applications.

If both power and frequency regulators in the MGC-1 are used, the dynamic of the two regulators should normally be set equal.

9. Check synchronisation with demounted GCB-ON output signal so the MGC-1 can not synchronise. Check that the sync-pulse is present at the exact point of synchronisation, by using a synchronoscope. If the synchronisation does not start as expected check all conditions that starts the synchronisation e.g. breaker position feedback, start regulation input, voltage and frequency inside limits. When synchronising is checked the GCB-ON can be remounted.

10. Check load sharing and voltage control at different set-points and with different fast changes of set-point or fast changing load conditions. If the regulation has overshoot or even become unstable, or if the regulation is slower than expected, the regulator parameters Gain and Time-pulse must be changed. If the regulation is stable, but there are constant small corrections in the regulation, the parameter insensitivity must be changed. If the regulation does not start as expected check all conditions that starts the regulation e.g. breaker position feedback, mode inputs, and start regulation input.

11. If Option C is in the product, set up the analog output type and output range. See paragraph 9.27.

12. Check the analog outputs by sweeping through 3 to 10 measuring points inside the measuring range of each output.

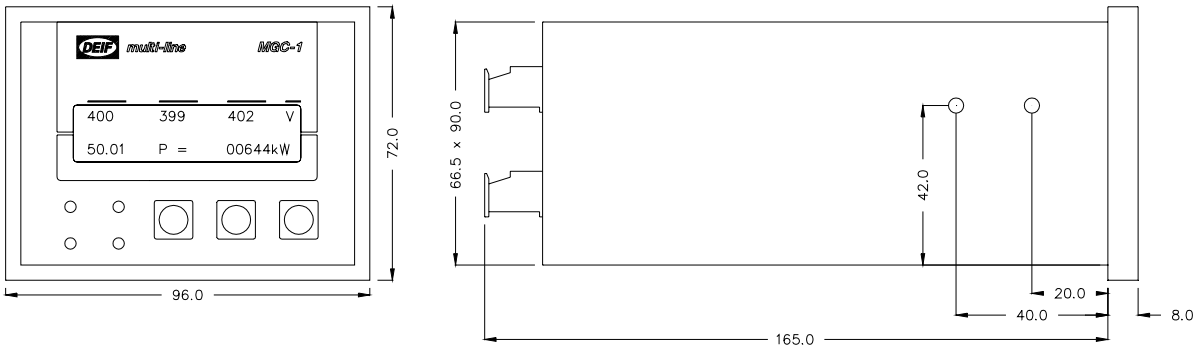
13. Finalize the commissioning by writing all programmed parameters into the tables in paragraph 9 and setting password ON to protect the settings entered into the unit.

7 Technical data

Accuracy	Class 1.0 acc. to IEC 688
Operating temp.	-20...+70 ^{o}C (LC display, however: -20...+60 ^{o}C)
Climate	Class HSE, to DIN 40040
Measuring voltage	100/110 VAC to 450 VAC ± 20% consumption max. 0.15 VA per phase
Measuring current	../1 or ../5 A, consumption max. 0.1 VA per phase max. overcurrent 3 x $I_{nom.}$continuously (measured), max 20 x $I_{nom.}$for 1s (not measured).
Measuring frequency	30Hz...70Hz
Aux. Supply	Standard 24 VDC -25/+30%, max 6W Optional 12-48-110-220V DC +30/-25%, max 6W
Binary inputs	input voltage 18...250 VDC or VAC input impedance 68 k
Relay inputs	Contact rating : 8 A @250 VAC max. voltage 380 VAC Mechanical lifetime min. 100.000 changeovers
Analog input	0..20mA, load 250Ω
Load sharing line	0...5V DC, input/output impedance 5kΩ
Analog outputs (Option B1…B3)	Outputs for electronic speed governor or electronic voltage regulator -5...5V.
Analog outputs (Option C)	Analog transducer outputs (0)4...20mA or -20...0...20mA load max 400
Open collector output	Max. 30mA ON" current, max 27V "OFF" voltage.
Safety	To EN 61010-1 Installation category (Overvoltage category) III, 300V. Pollution degree 2
Galvanic separation	Between all binary input groups and remaining circuit Between all relay outputs and between relay outputs and remaining circuits Between all current inputs and between current inputs and remaining circuits Between open collector output and remaining circuits Between analog outputs and remaining circuits (Option B and C)
EMC	To EN 50081-1/2 and EN 50082-1/2
Housing	DIN 43700, WxHxD: 96x72x165, cutout 92x68 mm
Connections	Max. 4 mm^2 (Current inputs). Max. 2,5 mm^2 (Generator voltage, power supply, Reset/inhibit input, GCB open input, start synchronise/load share input and relay outputs). Max. 1,5 mm^2 (All others)
Protection	IP 21, Front IP 52. To IEC 529 and EN 60529
Weight	Dependent on version, approx. 0.6 kg

8 Dimensions

All dimensions in mm.



9 Programming parameters

In the following part of the manual it is described how MGC-1 is programmed to the desired functionality. Each of the parameters that can be changed is explained in details. This part of the manual is intended as a reference manual that explains all parameters in the order they appear in the display. It is not meant as a programming guide that must be read before any parameters are entered. Programming MGC-1 is highly self-explaining, and this part of the manual should therefore be used as a reference when further explanations are needed. It is recommended to use the blank column "commissioning value" in each of the tables with parameters below to write down your own settings after commissioning. This will make it easier to track changes after commissioning or to reprogram the unit, if this should become necessary. The display texts that are shown below are in English language. If German display texts are selected, a different display dialogue is to be expected.

9.1 Select parameter entering mode

By pushing the buttons "V/A" and "ACK" simultaneously the unit swaps between normal operating mode and parameter entering mode. The functions of the buttons "LOG", "V/A" and "ACK" are changed to the indications below the buttons, i.e. "LOG" turns to "P", "V/A" turns to "▲" and "ACK" turns to "▶". The "MON" LED will flash.

The first thing shown in the display in parameter entering mode is "Adjust settings, [press P]" and after pressing "P" the software version is displayed.

The functionality of each of the buttons is explained in details in paragraph 3.3 "pushbuttons".

If no parameter setting inputs has taken place for 2 min., the MGC-1 will return to normal operating mode.

To make key-in of values easier, all buttons have a "sweep" function. By holding a button down, a fast sweep through values can be carried out.

To make it possible to return to a known set of parameters, the unit can be programmed to factory settings (shown in the tables below) by holding all 3 pushbuttons down for 20 sec.,

when the unit is in the start of parameter entering mode, and the display shows "Adjust settings, [press P]". The display will show "settings load" when factory settings are loaded. Be careful when using this function. All programmed parameters that differs from factory setting will be lost. Reprogramming to factory settings cannot be done when the unit is in normal operating mode.

9.2 Language selection

Display	Factory set	Commis-sioning value	Description
SPRACHE/LANGUAGE English	English		Can be switched between English and German.

9.3 Password protection 1

Password protection is divided into 2 parts. Password 1 prevents unauthorised entering into the part of the parameter entering mode where operation parameters that are used daily is adjusted. Password 2 prevents unauthorised entering into the part of the parameter entering mode where commissioning parameters are adjusted.

The password is a 5-digit code number.

At time of delivery, the password protection is OFF, and without the setting "password ON", the parameter setting will remain unprotected. It is, however, highly recommended to enable the password protection after end of parameter setting.

Display	Factory set	Commis-sioning value	Description
Enter Password 1 XXXXX	00001		This display is only shown when password is set ON in the menu below.
When a wrong password is entered, the display below is shown, and the unit returns to the "enter password" display when P is pressed.			
Wrong Password! Press "P"			Nothing can be programmed here.
When a correct password is entered, the display below is shown.			
Password 1 Protection OFF			Can be programmed ON or OFF.
Enter new Password 1 ?????			Here it is possible to change password 1. Be sure to note the new password every time it is changed. After coding a new password the coded password is substituted with ????? in the display when "P" is pressed. Remember to press "P" second time to move to next parameter.

9.4 Daily-use parameters

Display	Factory set	Commissioning Value	Description
Freq. Controller set-point XX,XHz	50,0 Hz		32...68Hz Set-point for frequency controller. This display is only shown when internal reference is selected to frequency controller.
Power controller set-point =XXXXXkW	00100 kW		0kW...32.000kW. Set-point for power controller in Power control mode. This display is only shown when internal reference is selected to power control mode.
Volt. Controller set-point XXXXXX			10...480V . Set-point for voltage controller. This display is only shown when option A is ordered and selected.
Power fact controller Set-point X,XX	1,00		K0,70..i0,70 Set-point for power factor. This display is only shown when option A is chosen and “volt controller in Preg mode: cos” is chosen. The unit will keep the generator power factor constant, when “Fixed power mode” running is chosen.
React.Pow.contr. Setp. XXXXXvar	00000 var		0...32.000kVAR Set-point for var. This display is only shown when option A is chosen and “volt controller in Preg mode: var” is chosen. The unit will keep the generator reactive power constant, when “Fixed power mode” running is chosen.

9.5 Password protection 2

The password prevents unauthorised entering into the part of the parameter entering mode where commissioning parameters are adjusted.

The password is a 5-digit code number.

At time of delivery, the password protection is OFF, and without the setting "password ON", the parameter setting will remain unprotected. It is, however, highly recommended to enable the password protection after end of parameter setting.

Display	Factory set	Commissioning value	Description
Enter Password 2 XXXXX	00002		This display is only shown when password is set ON in the menu below.
When a wrong password is entered, the display below is shown, and the unit returns to the "enter password" display when P is pressed.			
Wrong password! Press "P"			Nothing can be programmed here.
When a correct password is entered, the display below is shown.			

Password 2 protection OFF			Can be programmed ON or OFF.
Enter new Password 2 ?????			Here it is possible to change password 2. Be sure to note the new password every time it is changed. After coding a new password the coded password is substituted with ????? in the display when "P" is pressed. Remember to press "P" second time to move to next parameter.

9.6 Gen-set parameters

Display	Factory set	Commissioning value	Description
Volt. Measuring Phase to phase	Phase to Phase		Phase to phase/Phase-neutral. Selection of voltage measurement method and display voltage value indication.
Volt. Transformer secondary XXXV	100 V		50...480V.
Volt. Transformer primary XX,XX kV	00,40 kV		00,10kV...65,00kV.
Current transformer XXXX/X	1000/5		10/5...9990/5. The secondary on the current trafo can be either 5 or 1 depending on which current trafo option is ordered, but the secondary current trafo value can not be changed after order.
Nominal current =XXXXA	1000A		10A...9990A. This setting affects all current relays that are set in % of primary current.
Nominal power =XXXXXkW	00500 kW		5kW...32.000kW. This setting affects all power measuring and relaying and regulators that is set in % of nominal power.
Power measuring Three-phase	Three-phase		Can be set to either three-phase or one-phase. This setting affects all power regulators and protectors. One-phase power measurement can be used in systems with only 1 current trafo.

9.7 Synchronising

Set-points for maximum allowed U is related to the secondary of the voltage transformer (the connections to MGC-1), if the system includes voltage transformers. The setting does not calculate the programmed voltage transformer into the set-points.

Display	Factory set	Commis-sioning value	Description
Synchronising functions ON	OFF		Can be set to ON or OFF. Enables or disables the synchroniser. The parameter-displays shown below is not shown, when synchronising functions is OFF.
Synchronisation df max. X,XXHz	0,18Hz		0,00....0,49Hz Sets the maximum allowed slip frequency in synchronising moment. A positive value means that the generator will export power when it is synchronised.
Synchronisation df min. -X,XXHz	-0,10Hz		-0,00....-0,49Hz Sets the minimum allowed slip frequency in synchronising moment. A negative value means that the generator will gene-rate import power when it is synchronised.
Synchronisation dU max. XXV	06V		2...60V Sets the maximum allowed voltage difference between busbar and generator in synchronising moment.
Gen. Circ. Breaker Steady sign OFF	OFF		Can be programmed as either ON or OFF. When programmed to OFF a sync pulse on the below defined length will be given at synchronisation. When programmed as ON the output relay will go ON when sync-hronising and go OFF when breaker posi-tion input "Breaker open" becomes active.
Synchronisation Time pulse >XXXms	200ms		50...250ms. Sets the length of the sync. Time pulse.
Gen. Circ. Breaker pick-up t. XXX ms	080ms		040...300ms. Sets the closing time of the breaker. The sync pulse will be given the adjusted time before synchronisation moment to ensure operation of the breaker at the right time.
Synchronisation volt. Match ON	OFF		Can be set to ON or OFF. Enables voltage regulating through the AVR output when synchronising. No voltage regulation after synchronisation. Option A is needed to regulate voltage after synchronisation.
Black busbar Operation ON	OFF		Can be set to ON or OFF. Enables closing of the GCB when busbar is "black". See paragraph 1.1.

Black busbar op. df max = X,XXHz	0,25 Hz		0,05...2,00Hz Allowed frequency difference between generator frequency and frequency controller set-point when a black busbar operation can be performed. This display is not shown, when black busbar operation is OFF.
Black busbar op. dU max = XXV	10 V		01...60V Allowed voltage difference between generator voltage and secondary of voltage transformer setting when a black busbar operation can be performed. This display is not shown, when black busbar operation is OFF.

9.8 Power or frequency regulation/load sharing

Display	Factory set	Commis-sioning value	Description
The following settings refer to frequency controller.			
Freq. Controller	ON		Can be set to ON or OFF. Enables or disables the frequency control mode. The parameter-displays below is not shown, when frequency control is OFF.
Freq. Controller Source	Intern		Can be set to either intern or extern set-point. If internal set-point is selected a display for adjusting set-point appears in the "daily use" part of the parameter setting, see paragraph 10.4.
Freq. Controller Set-point XX,XHz	50,0 Hz		32,0...68,0Hz Set-point for frequency controller. This display is only shown when internal reference is selected. This setting is similar to the frequency controller set-point under daily use parameters.
External setp. 0mA = XX,XHz	48,0 Hz		32,0...68,0Hz Sets the range of the set-point input. This display is only shown when external set-point source is selected.
External setp. 20mA = XX,XHz	52,0 Hz		32,0...68,0Hz Sets the range of the set-point input. This display is only shown when external set-point source is selected.
The following 4 menu settings are settings for the frequency regulator (step controller) when relay outputs regulate "UP" and "DOWN" are used (Option B1 or B3 NOT included in the unit). Regulator settings for power and frequency regulators must be set as close to each other as possible to ease switching between frequency and power regulators.			

Freq. Controller Insens X,XXHz	0,10 Hz		0,02...1,00Hz Sets the frequency difference from the set-point where there is no regulation.
Freq. Controller sens.red. * X,X	2,0		1,0...9,9 After 5 sec. Where the regulator is inside the insensitive band set above, the insensitive band is widened with the adjusted factor. This will give reduction in governor wear.
Freq. Controller Time pulse> XXXms	80ms		10...250ms Sets the pulse length of the frequency controller.
Freq. Controller Gain Kp= XX,X	10,0		0,1...99,9 Sets the gain of the frequency controller.
The following 3 menu settings are settings for the frequency regulator (PID-controller) when analog regulator outputs are used (Option B1 or B3 included in the unit) Regulator settings for power and frequency regulators must be set as close to each other as possible to ease switching between frequency and power regulators.			
Pr.-sensivity Freq. Kpr= XXX	030		0...240 Regulator gain
Reset time Freq.Tn= XX,X s	02,5s		00,0...60,0s Adjusts the integrator reset time. 00,0s means no integral effect. **NOTE:** To be set as low as possible, otherwise the time to reach the actual set-point will be too long.
Derivate act. Time (freq) X,XX s	0,20s		0,00...6,00s Adjusts the derivate time. 0,00s means no differential effect.
Freq. Controller Droop XX,X%	05,0%		00,0...20,0% Sets the speed droop. The setting is made in % of nominal frequency. The frequency is adjusted the selected range versus the range of generated power from 0 kW to nominal power.
There is no individual setting for Speed droop mode. The speed droop is set under frequency control mode.			
The following setting is for Power summation mode. The nominal power is set as a general setting and regulator power is set under Power controller.			
Power/freq. reg. Frequency XXX%	50%		0...100% Sets the weighing between frequency and power regulation as defined in paragraph 1.2

9.9 Power controller

Power limitation P max. XXX%	100%		10...120% Limits the range of power to which the MGC-1 can regulate.
Power controller Source intern	extern		Can be set to either internal or external set-point. If internal set-point is selected the nominal power in the "daily use" part of the parameter setting will be set-point, see paragraph 10.4.
Power controller Set-point = XXXXkW	00500Kw		0...32000kW. Set-point for power controller in power control mode. This display is only shown when internal reference is selected. This setting is similar to the power controller set-point under daily use parameters.
External setp. 0mA = XXXXXkW	0kW		0kW...32.000kW Sets the range of the set-point input. This display is only shown when external set-point source is selected.
External setp. 20mA = XXXXXkW	500 kW		0kW...32.000kW Sets the range of the set-point input. This display is only shown when external set-point source is selected.
Power controller Ramp XXX%/s	010 %/s		0...100%/s Sets a ramp for regulating power up in % of nominal power. If the ramp is not desired it is adjusted to 100%. The ramp has no effect on regulating power down.
The following 4 menu settings are settings for the power regulator (step controller) when relay outputs regulate "UP" and "DOWN" are used (Option B1 or B3 NOT included in the unit) Regulator settings for power and frequency regulators must be set as close to each other as possible to ease switching between frequency and power regulators.			
Power controller Insens XX,X%	02,5%		0,1...20,0% Sets the power difference from the set-point where there is no regulation.
Power controller sens.red. * X,X	2,0		1,0...9,9 After 5 sec. Where the regulator is inside the insensitive band set above, the insensitive band is widened with the adjusted factor. This will give reduction in governor wear.
Power controller Time pulse> XXXms	80ms		10...250ms Sets the pulse length of the power controller.
Power controller Gain Kp= XX,X	5,0		0,1...99,9 Sets the gain of the power con-troller.
The following 3 menu settings are settings for the power regulator (PID-controller) when analog regulator outputs are used (Option B1 or B3 included in the unit) Regulator settings for power and frequency regulators must be set as close to each other as possible to ease switching between frequency and power regulators.			
Pr.-sensivity Powr Kpr= XXX	030		0...240 Regulator gain
Reset time Power Tn= XX,X s	02,5s		00,0...60,0s Adjusts the integrator reset time. 00,0s means no integral effect. **NOTE:** To be set as low as possible,

			otherwise the time to reach the actual set-point will be too long.
Deriv. Act. Time Power X,XX s	0,20s		0,00...6,00s Adjusts the derivate time. 0,00s means no differential effect. No differential effect is desirable in most power regulating applications.
Power reduction Set-point XXX%	015%		5...110% This display can set a fixed power to which the generator is regulated after synchronisation. The time after synchronisation before the normal set-point is used is set below. This function gives a soft load of the generator after synchronisation. This function is only active in power regulation mode.
Power reduction Time XXXs	005s		0...600s Sets the time after synchronisation where the above power reduction set-point is used.

9.10 Voltage control/Cosφ control/VAR control

Display	**Factory set**	**Commis-sioning value**	**Description**
Volt Controller ON	ON		ON/OFF. Selection of activated/de-activated voltage/cos/var controller after closing of breaker.
The following 3 menu settings are settings for the voltage regulator (step controller) when relay outputs regulate "UP" and "DOWN" are used (Option B2 or B3 NOT included in the unit)			
Volt. Controller Insens XX,X%	01,0%		0,1...10,0% Sets the difference from the set-point where there is no regulation. The setting is expressed in % of the set-point.
Volt. Controller Time pulse> XXXms	80ms		10...250ms Sets the pulse length of the voltage controller.
Volt. Controller Gain. Kp = XX,X	10,0		0,1...99,9 Sets the gain of the voltage controller.

The following 3 menu settings are settings for the voltage regulator (PID-controller) when analog regulator outputs are used (Option B2 or B3 included in the unit)			
Pr.-sensivity Volt. Kpr= XXX	030		0...240 Regulator gain
Reset time Volt. Tn = XX,X s	02,5s		00,0...60,0s Adjusts the integrator reset time. 00,0s means no integral effect.
Derivate act. time Volt. X,XX s	0,20s		0,00...6,00s Adjusts the derivate time. 0,00s means no differential effect.
Volt. Controller Droop XX,X%	05,0%		00,0...20,0% Sets the droop rate for the voltage controller. The setting is made in % of nominal voltage. The voltage is adjusted to the selected range versus the range of generated reactive power from 0 kW to set-point for reactive power controller. Voltage droop is only active for voltage controller selected.
The following settings are only active for option A.			
Volt. Controller In Preg. Mode: cos	cos		Cos/var. Selection of voltage controller function when constant power mode is selected.
The following 3 menu settings are only active if voltage controller in Preg. mode is selected to be cos			
Pow. Fac. Controller Set-point 1,00	1,00		k0,7…i0,7. Adjusts the set-point for power factor between capacitive (k) and inductive (i) value.
The following 2 settings are only active if relay output is used for voltage control (option B2 or B3 not selected).			
Pow. Fac. Controller Insens. 2,5%	2,5%		0,1...10,0% Sets the difference from the set-point where there is no regulation. The setting is expressed in % of the set-point.
Pow. Fac. Controller Gain Kp= 05,0%	5,0%		0,1...99,9 Sets the gain of the power factor controller.
The following 3 menu settings are settings for the power factor controller regulator (PID-controller) when analog regulator outputs are used (Option B2 or B3 included in the unit)			
Pr.-sensivity Cos. Kpr= XXX	030		0...240 Regulator gain
Reset time Cos. Tn = XX,X s	02,5s		00,0...60,0s Adjusts the integrator reset time. 00,0s means no integral effect.
Derivate act. Time cos. X,XX s	0,20s		0,00...6,00s Adjusts the derivate time. 0,00s means no differential effect.
The following 3 menu settings are only active if voltage controller in Preg. mode is selected to be var			
React.pow.contr. Setp. 00000kvar	00000		-32000k…+32000kvar. Adjusts the set-point for reactive power between capacitive (-) and inductive (+) value.

The following 2 settings are only active if relay output is used for voltage control (option B2 or B3 not selected).			
React.pow.contr. Insens. 2,5%	2,5%		0,1...10,0% Sets the difference from the set-point where there is no regulation. The setting is expressed in % of the set-point.
React.pow.contr. Gain Kp= 05,0%	5,0%		0,1...99,9 Sets the gain of the reactive power controller.
The following 3 menu settings are settings for the reactive power controller regulator (PID-controller) when analog regulator outputs are used (Option B2 or B3 included in the unit)			
Pr.-sensivity var Kpr= XXX	030		0...240 Regulator gain
Reset time var. Tn = XX,X s	02,5s		00,0...60,0s Adjusts the integrator reset time. 00,0s means no integral effect.
Derivate act. Time var X,XX s	0,20s		0,00...6,00s Adjusts the derivate time. 0,00s means no differential effect.

9.11 Stop sequence (normal stop)

Stop sequence ON	ON		ON/OFF. Selection of ramp down function and trip of breaker at 10% active load if the "start sync./reg" is deactivated during running (breaker closed).
Stop sequence Ramp 002%/s	002		001…100%/s. Setting of ramp down speed during stop sequence. In percentage of nominal power.

9.12 Power maximum relay output (Option H)

Set-points for power maximum relay is related to the programmed nominal power. This function can be used to start next gen-set when the generated power on this gen-set is over the adjusted limit. The display settings shown below are only active when option H is ordered. The function is similar to that of a power monitoring function, but there are no alarm messages associated to this function. An output relay can be allocated to this function with the relay manager (see paragraph 9.26), but be careful not to allocate protection functions to the same output as the power maximum output relay.

Display	**Factory set**	**Commis-sioning value**	**Description**
Power max Output ON			Can be set to ON or OFF. Enables or disables power maximum output. The parameter-displays shown below is not shown, when power maximum output is OFF.
Start next gen. At = XXX%	80%		0%...120% The limit where the output is activated to start next generator.

Start next gen. Delay = XXX,Xs	045,0s		000,0s..320,0s The time delay from the adjusted limit is exceeded to the output reacts.
Start next gen. Rel. Delay = XXX,Xs	045,0s		000,0s..320,0s The time delay from the power goes under the adjusted limit minus hysteresis to the output falls back to normal state.
Hysteresis Start next gen XXX%	60%		1%...100% The hysteresis is the decrease in power before start next generator output is reset back to normal to stop the next generator again. With the two indicated factory settings the output signal will start next generator at 80% nominal load and stop next generator at 80-60%=20% nominal load.

9.13 Overvoltage monitoring

Set-points for overvoltage monitoring is related to the secondary of the voltage transformer (the connections to MGC-1), if the system includes voltage transformers. The setting does not calculate the programmed voltage transformer into the set-points. The set-points relates to phase to phase voltages or phase-Neutral voltages depending on the setting.

Display	**Factory set**	**Commissioning value**	**Description**
Volt.-Monitoring phase to phase	phase to phase		Can be set to either phase to phase or phase-neutral depending on the generator. This selection is only present if "voltage measuring phase-neutral" is selected.
Overvoltage Monitoring ON			Can be set to ON or OFF. Enables or disables overvoltage monitoring. The parameter-displays shown below is not shown, when overvoltage monitoring is OFF.
Overvoltage 1 V(ph-ph) >XXXV	110V		10V...520V
Overvoltage 1 Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Overvoltage 2 V(ph-ph) >XXXV	120V		10V...520V
Overvoltage 2 Delay XX,XXs	00,04s		00,02s...99,98s Can be adjusted in steps of 20ms
Overvoltage Hysteresis XXV	02V		00V...99V The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.14 Undervoltage monitoring

Set-points for undervoltage monitoring is related to the secondary of the voltage transformer (the connections to MGC-1), if the system includes voltage transformers. The setting does not calculate the programmed voltage transformer into the set-points.

Display	Factory set	Commis-sioning value	Description
Undervoltage Monitoring ON			Can be set to ON or OFF. Enables or dis-ables undervoltage monitoring. The parameter-displays shown below is not shown, when undervoltage monitoring is OFF.
Undervoltage 1 V(ph-ph) <XXXV	90V		20V...520V
Undervoltage 1 Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Undervoltage 2 V(ph-ph) <XXXV	80V		20V...520V
Undervoltage 2 Delay XX,XXs	00,04s		00,02s...99,98s Can be adjusted in steps of 20ms
Undervoltage Hysteresis XXV	02V		00V...99V The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.15 Asymmetry monitoring

Set-points for asymmetry monitoring is related to the secondary of the voltage transformer (the connections to MGC-1), if the system includes voltage transformers. The setting does not calculate the programmed voltage transformer into the set-points.

Display	Factory set	Commis-sioning value	Description
Asymmetry Monitoring ON			Can be set to ON or OFF. Enables or disables asymmetry monitoring. The parameter-displays shown below is not shown, when asymmetry monitoring is OFF.
Asymmetry release v. XXV	10V		00V..99V
Asymmetry Delay XX,XXs	02,00s		00,02s...99,98s Can be adjusted in steps of 20ms
Asymmetry Hysteresis XXV	01V		00V...99V The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.16 Overfrequency monitoring

Display	Factory set	Commissioning value	Description
Overfrequency-Monitoring ON			Can be set to ON or OFF. Enables or disables overfrequency monitoring. The parameter-displays shown below is not shown, when overfrequency monitoring is OFF.
Overfrequency 1 F >XX,XXHz	50,20Hz		30,00Hz...70,00Hz
Overfrequency 1 Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Overfreqency 2 F XX,XXHz	51,00Hz		30,00Hz...70,00Hz
Overfrequency 2 Delay XX,XXs	00,04s		00,02s...99,98s Can be adjusted in steps of 20ms
Overfrequency Hysteresis X,XXHz	0,05 Hz		0,01Hz..9,99Hz The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.17 Underfrequency monitoring

Display	Factory set	Commissioning value	Description
Underfrequency-Monitoring ON			Can be set to ON or OFF. Enables or disables underfrequency monitoring. The parameter-displays shown below is not shown, when underfrequency monitoring is OFF.
Underfrequency 1 F <XX,XXHz	49,80Hz		30,00Hz...70,00Hz
Underfrequency 1 Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Underfrequency 2 F <XX,XXHz	49,00Hz		30,00Hz...70,00Hz
Underfrequency 2 Delay XX,XXs	00,04s		00,02s...99,98s Can be adjusted in steps of 20ms
Underfrequency Hysteresis X,XXHz	0,05 Hz		0,01Hz..9,99Hz The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.18 Phasejump monitoring

This part of the programming is only showed when option E is ordered.

Display	Factory set	Commissioning value	Description
Phase jump- Monitoring ON			Can be set to ON or OFF. Enables or disables phase jump monitoring. The parameter-displays shown below is not shown, when phase jump monitoring is OFF.
Phase jmp monit. 3 phase only	3 phase only		Can be set to either 3 phase only or one/three phase. Decides whether the phase jump must occur in all 3 phases at the same time before a phase jump is recognised, or if the phase jump monitoring must be combination of single phase and 3 phase monitoring.
Phase-jump value (One phase) XX°	30°		30°...90° Only shown when combined single phase and 3 phase monitoring is selected. The phase jump relay reacts immediately without delay, when a phase jump is detected.
Phase-jump value (3-phase) XX°	8°		08°...90° The phase jump relay reacts immediately without delay, when a phase jump is detected.

9.19 Df/dt monitoring

This part of the programming is only shown when option F is ordered.

Display	Factory set	Commissioning value	Description
df/dt Monitoring ON			Can be set to ON or OFF. Enables or disables df/dt monitoring. The parameter-displays shown below is not shown, when df/dt monitoring is OFF.
df/dt release >X,XHz/s	2,5Hz/s		1,0Hz/s...9,9Hz/s
df/dt Delay T= X,Xs	0,1s		0,1s..9,9s

9.20 Overcurrent monitoring

Set-points for overcurrent monitoring is in % related to the programmed nominal current.

Display	Factory set	Commissioning value	Description
Overcurrent Monitoring ON			Can be set to ON or OFF. Enables or disables overcurrent monitoring. The parameter-displays shown below is not shown, when overcurrent monitoring is OFF.
Overcurrent 1 I >XXX%	120%		1%...240%
Overcurrent 1 Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Overcurrent 2 I >XXX%	160%		1%...240%
Overcurrent 2 Delay XX,XXs	00,04s		00,02s...99,98s Can be adjusted in steps of 20ms
Overcurrent Hysteresis XXX%	5%		1%...240% The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.21 Overload monitoring

Set-points for overload monitoring is related to the programmed nominal power.

Display	Factory set	Commissioning value	Description
Overload Monitoring ON			Can be set to ON or OFF. Enables or disables overload monitoring. The parameter-displays shown below is not shown, when overload monitoring is OFF.
Overload Release v. =XXX%	120%		80%...150%
Overload Delay time = XXXs	020s		000s..300s
Overload Hysteresis XXX%	2%		1%...99% The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.22 Reverse/minimum power monitoring

Set-points for reverse/minimum power monitoring is related to the programmed nominal power.

Display	Factory set	Commissioning value	Description
Reverse/min.pow. Monitoring ON			Can be set to ON or OFF. Enables or disables reverse/minimum power monitoring. The parameter-displays shown below is not shown, when reverse/minimum power monitoring is OFF.
Reverse power/ Min. Power =XXX%	-10%		-99%...+99% Negative value means reverse power.
Reverse power Delay XX,XXs	03,00s		00,02s...99,98s Can be adjusted in steps of 20ms
Reverse power Hysteresis XX%	02%		1%...99% The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.23 Unbalanced load monitoring

Set-points for unbalanced load monitoring is related to the programmed nominal power.

Display	Factory set	Commissioning value	Description
Unbalanced load Monitoring ON			Can be set to ON or OFF. Enables or disables unbalanced load monitoring. The parameter-displays shown below is not shown, when unbalanced load monitoring is OFF.
Unbalanced load Release v. XXX%	20%		000%...100%
Unbalanced load Delay XX,XXs	01,00s		00,02s...99,98s Can be adjusted in steps of 20ms
Unbalanced load Hysteresis XX%	05%		1%...99% The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.24 Reactive power monitoring

Display	Factory set	Commis-sioning value	Description
Reactive power Monitoring ON			Can be set to ON or OFF. Enables or disables reactive power monitoring. The parameter-displays shown below is not shown, when reactive power monitoring is OFF.
Cap. React. Pow. Release v. =XXX%	30%		000%...100%
Cap. React. Pow. Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Ind. React. Pow. Release v. =XXX%	30%		000%...100%
Ind. React. Pow. Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
React. Pow. Mon. Hysteresis XX%	04%		1%...99% The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.25 Busbar voltage monitoring

Set-points for busbar voltage monitoring is related to connectors of MGC-1. If there are voltage transformers in the system the settings are therefore expressed as the voltage on the secondary of the voltage transformers.

Display	Factory set	Commis-sioning value	Description
busbar voltage Monitoring ON			Can be set to ON or OFF. Enables or disables busbar voltage monitoring. The parameter-displays shown below is not shown, when busbar voltage monitoring is OFF.
Busbar overvolt. U> XXXV	110V		20...520V
Busbar overvolt. Delay XX,XXs	01,00s		00,02s...99,98s Can be adjusted in steps of 20ms
Busbar undervolt. U< XXXV	090V		20...520V
Busbar undervolt. Delay XX,XXs	01,00s		00,02s...99,98s Can be adjusted in steps of 20ms
Busbar voltage Hysteresis XXV	02V		1V...99V The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.26 Busbar frequency monitoring

Display	Factory set	Commis-sioning value	Description
busbar frequency Monitoring ON			Can be set to ON or OFF. Enables or disables busbar frequency monitoring. The parameter-displays shown below is not shown, when busbar frequency monitoring is OFF.
Busbar overfreq. f> XX,XXHz	50,20Hz		30...70Hz
Busbar overfreq. Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
Busbar underfreq. U< XXXV	49,80 Hz		30...70Hz
Busbar underfreq Delay XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms
busbar frequency Hysteresis X,XXHz	0,05 Hz		0,01...9,99Hz The hysteresis is the change in measured value needed before alarm is reset back to normal after once being tripped.

9.27 Alarm message and relay output settings

Display	Factory set	Commis-sioning value	Description
External Clearing ON	OFF		Can be set to ON or OFF. Enables or disables external acknowledge of alarms through reset/inhibit input. If External clearing is set to OFF and the Reset inhibit line is used, the outputs will be cleared as long as reset/inhibit is active, but the outputs will return when reset inhibit is inactive again.
Auto-clearing Relays ON	ON		Can be set to ON or OFF. When enabled the output relays will automatically fall back to normal without acknowledge when an alarm state is cleared. The parameter-displays setting release delay shown below is not shown, when auto clearing relays is OFF.
Release delay Overvolt. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when overvoltage monitoring is enabled.

Release delay Und.volt. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when undervoltage monitoring is enabled.
Release delay Asymmetry XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when asymmetry voltage monitoring is –enabled.
Release delay Overfreq. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when overfrequency monitoring is enabled.
Release delay Underfrq. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when underfrequency monitoring is enabled.
Release delay Phase jmp. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when phase jump monitoring is enabled.
Release delay df/dt XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when df/dt monitoring is enabled.
Release delay Overcurr. XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when overcurrent monitoring is enabled.
Release delay Overload XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when overload monitoring is enabled.

Release delay Rev.power XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when reverse/minimum power monitoring is enabled.
Release delay Asy. Load XX,XXs	00,25s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when asymmetry load monitoring is enabled.
Release delay react. Q- XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when capacitive reactive power monitoring is enabled.
Release delay react. Q+ XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when inductive reactive power monitoring is enabled.
Release delay busb. Vol XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when busbar voltage monitoring is enabled.
Release delay busb. Frq XX,XXs	00,10s		00,02s...99,98s Can be adjusted in steps of 20ms. Sets the delay from clearing the alarm state till output relay falls back. This display is only shown when busbar frequency monitoring is enabled.
Auto-clearing Display ON	ON		Can be set to ON or OFF. When enabled the alarm messages on the display will automatically disappear without acknowledge when an alarm state is cleared. The parameter-displays setting release delay shown below is not shown, when auto clearing display is OFF.
Clearing display After XXs	01s		01s...99s This timer setting is common for all monitoring functions

9.28 Output relay allocation (Relay manager)

It is possible to change which relays the different monitoring functions can operate and if the relays should be normally closed or normally open. Thereby the output relays can be controlled very flexible to give the desired output without any external interfacing relays. Each protection function can control 4 different outputs. If an output is controlled by more than 1 protection function, the output will react on all protection functionalities (logic-OR functionality).

Display	Factory set	Commis-sioning value	Description
Change relay-Allocation? YES	YES		Can be set to YES or NO. Enables or disables changing of the relay allocation. The parameter-displays shown below for changing relay allocation is not shown, when changing relay allocation is off.
Funct. Relay 123 (R=Releases) REE	REE		Can be set to either R or E for relay 2 and relay 3. Relay 1 is fixed to be R. R means that the relay is normally closed. E means that the relay is normally open.
Start next gen. to relay 0003	0003		Start next generator can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects start next generator to the relay number shown. Relay 0 means not connected. This display is only shown when start next generator function is enabled.
Overvoltage 1 to relay 0002	0002		Overvoltage1 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overvoltage 1 to the relay number shown. Relay 0 means not connected. This display is only shown when overvoltage 1 is enabled.
Overvoltage 2 to relay 0002	0002		Overvoltage 2 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overvoltage 2 to the relay number shown. Relay 0 means not connected. This display is only shown when overvoltage 2 is enabled.

Undervoltage 1 to relay 0002	0002		Undervoltage 1 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects undervoltage 1 to the relay number shown. Relay 0 means not connected. This display is only shown when undervoltage 1 is enabled.
Undervoltage 2 to relay 0002	0002		Undervoltage 2 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects undervoltage 2 to the relay number shown. Relay 0 means not connected. This display is only shown when undervoltage 2 is enabled.
Asymmetry to relay 0002	0002		Asymmetry can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects asymmetry to the relay number shown. Relay 0 means not connected. This display is only shown when asymmetry is enabled.
Overfrequency 1 to relay 0003	0003		Overfrequency 1 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overfrequency 1 to the relay number shown. Relay 0 means not connected. This display is only shown when overfrequency 1 is enabled.
Overfrequency 2 to relay 0003	0003		Overfrequency 2 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overfrequency 2 to the relay number shown. Relay 0 means not connected. This display is only shown when overfrequency 2 is enabled.
Underfrequency 1 to relay 0003	0003		Underfrequency 1 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects underfrequency 1 to the relay number shown. Relay 0 means not connected. This display is only shown when under-frequency 1 is enabled.
Underfrequency 2 to relay 0003	0003		Underfrequency 2 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects underfrequency 2 to the relay number shown. Relay 0 means not connected. This display is only shown when underfrequency 2 is enabled.

Phase jump to relay 0002	0002		Phase jump can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects phase jump to the relay number shown. Relay 0 means not connected. This display is only shown when phase jump is enabled.
df/dt to relay 0002	0002		Df/dt can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects df/dt to the relay number shown. Relay 0 means not connected. This display is only shown when df/dt is enabled.
Overcurrent 1 to relay 0002	0002		Overcurrent 1 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overcurrent 1 to the relay number shown. Relay 0 means not connected. This display is only shown when overcurrent 1 is enabled.
Overcurrent 2 to relay 0002	0002		Overcurrent 2 can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects overcurrent 2 to the relay number shown. Relay 0 means not connected. This display is only shown when overcurrent 2 is enabled.
Overload to relay 0003	0003		Overload can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects Overload to the relay number shown. Relay 0 means not connected. This display is only shown when Overload is enabled.
Reverse power to relay 0003	0003		Reverse power can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects Reverse power to the relay number shown. Relay 0 means not connected. This display is only shown when Re- verse power is enabled.
Unbalanced load to relay 0002	0002		Unbalanced load can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects unbalanced power to the relay number shown. Relay 0 means not connected. This display is only shown when unbalanced power is enabled.

Cap.react.pow. to relay 0002	0002		Cap.react.pow. can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects Cap.-react.pow. to the relay number shown. Relay 0 means not connected. This display is only shown when Cap.react.pow. is enabled.
Ind.react.pow. to relay 0002	0002		Ind.react.pow. can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects Ind.-react.pow. to the relay number shown. Relay 0 means not connected. This display is only shown when Ind.react.pow. is enabled.
Busbar overvolt. to relay 0003	0003		Busbar overvoltage can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects busbar overvoltage to the relay number shown. Relay 0 means not connected. This display is only shown when busbar overvoltage is enabled.
Busbar undervolt. to relay 0003	0003		Busbar undervoltage can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects busbar undervoltage to the relay number shown. Relay 0 means not connected. This display is only shown when busbar undervoltage is enabled.
Busbar overfreq. to relay 0003	0003		Busbar overfrequency can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects busbar overfrequency to the relay number -shown. Relay 0 means not connected. This display is only shown when busbar overfrequency is enabled.
Busbar underfreq. to relay 0003	0003		Busbar underfrequency can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects busbar underfrequency to the relay number shown. Relay 0 means not connected. This display is only shown when busbar underfrequency is enabled.

Collect response to relay 0000	0000		Collect response means all monitoring functions except busbar voltage and frequency monitoring functions can be set to go to one relay by one setting, collect response can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects collect response to the relay number shown. Relay 0 means not connected.
Stop order To relay 0002	0002		Selects the relay to be activated when ramp down during stop sequence reaches 5%. This can be used to trip the generator breaker.

9.29 Analog output and pulse output configuration

MGC-1 is only supplied with analog outputs if option C is ordered. It is possible to change what measured value is put to the 3 different outputs, and it is also possible to scale the output range and change the output signal type.

The different measured signals it is possible to put on the analog outputs is:

Measured value	**Display showing**
Voltage neutral-phase 1	Vol 1
Voltage neutral-phase 2	Vol 2
Voltage neutral-phase 3	Vol 3
Average neutral-phase voltage	V N-ph
Highest neutral-phase voltage	V N-ph H
Lowest neutral-phase voltage	V N-ph L
Voltage phase 1-phase 2	Vol 1-2
Voltage phase 2-phase 3	Vol 2-3
Voltage phase 3-phase 1	Vol 3-1
Average phase-phase voltage	V ph-ph
Highest phase-phase voltage	V ph-ph H
Lowest phase-phase voltage	V ph-ph L
Frequency	Freq
Directional current phase 1	Cur (+/-) 1
Directional current phase 2	Cur (+/-) 2
Directional current phase 3	Cur (+/-) 3
Directional average current	Cur (+/-)
Directional highest current	Cur (+/-) H
Directional lowest current	Cur (+/-) L
Active power	Power
Reactive power	Re. Pow
Apparent power	Ap. Pow
Cos phi	Cos phi

The pulse output is always present:

Display	Factory set	Commis-sioning value	Description
Pulse/kWh Logic Negative			Can be set to either positive or negative. Determines the output signal type of the open collector energy counter output. Negative means that the output transistor is ON during the counting pulse. Positive means that the output transistor is OFF during the counting pulse.
Reset kWh/kvarh ON			Can be set to either ON of OFF. When set to ON the energy counter in the display can be reset to 0 by pressing the two buttons "LOG" and "V/A" simultaneously in 10s. When the two buttons are pressed the LED "MON" will start flashing. When the energy counter is reset the LED will stop flashing.
Analog. Output 1 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20mA. Changes the output type. The displays below showing settings for analog output 1 will not be shown when analog output 1 is set to OFF.
Analog. Output 1 Signal Power	Power		Changes what measured value will be shown on the output. Can be set to the different values shown above.
Analog. Output 1 Low point XXXXXX			Defines scaling of analog output 1 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. e.g.: 0mA = 0kW
Analog. output 1 high point XXXXXX			Defines scaling of analog output 1 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. e.g.: 20mA = 2000kW
Analog. output 1 high point XXXXXX			Defines scaling of analog output 1 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. eg: 20mA = 2000kW
Analog. Output 2 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20mA. Changes the output type. The displays below showing settings for analog output 2 will not be shown when analog output 2 is set to OFF.

Analog. Output 2 Signal Power	power		Changes what measured value will be shown on the output. Can be set to the different values shown above.
Analog. Output 2 Low point XXXXXX			Defines scaling of analog output 2 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. eg: 0mA = 0kW
Analog. Output 2 high point XXXXXX			Defines scaling of analog output 2 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. e.g.: 20mA = 2000kW
Analog. Output 3 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20mA. Changes the output type. The displays below showing settings for analog output 3 will not be shown when analog output 3 is set to OFF.
Analog. Output 3 Signal Power	power		Changes what measured value will be shown on the output. Can be set to the different values shown above.
Analog. Output 3 Low point XXXXXX			Defines scaling of analog output 3 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. e.g.: 0mA = 0kW
Analog. Output 3 high point XXXXXX			Defines scaling of analog output 3 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. e.g.: 20mA = 2000kW

9.30 Serial interface settings

If option D2 or D4 is in the unit a Modbus RTU protocol for a slave unit is implemented. The address on the multi-drop line can be set on display as explained below. Please refer to the manual "Serial interface, Multi-Line" for further explanations.

Device number Modbus 002	002		001…255. Address for the Modbus communication. Be careful not to use the same number more than once, as this will result in communication errors
Baudrate 19200 baud	19200		1200-2400-4800-9600-19200 baud selectable
Parity None	None		None-even-odd parity selectable
Stopbits one	one		One-two stopbits selectable
Delay to send MOD-bus 20.0 ms	20.0 ms		00,2…50.0 ms MOD-bus response delay

If option D4 is in the unit, MGC-1 can be controlled from the serial channel. The following menus will appear in the display:

Serial control ON			ON or OFF. If serial control is set to ON, it is possible to send control commands over the serial channel, if it is set to OFF all control commands will be ignored. Please refer to the manual “Serial interface, Multi-Line” for further explanations about control commands.
Serial interface Monitoring ON			ON or OFF. If serial control monitoring is ON the serial communication watchdog bits in the communication protocol must be updated every 15 sec. Please refer to the manual “Serial interface, Multi-Line” for further explanations about the serial communication watchdog bits.
Interface fault To relay 0000	0000		The serial interface monitoring can be set to operate 3 different relays. Each of the three numbers that can be adjusted connects the serial interface monitor to the relay number shown. Relay 0 means not connected. This display is only shown when serial interface monitoring is enabled.
Inhibit via Interface ON			ON or OFF. Enables the possibility of inhibiting all alarms (except overvoltage and overfrequency) through the serial interface.

9.31 Factory settings

This password gives access to factory settings, which can not be operated by customers. Do not operate this display

Display	**Factory set**	**Commissioning value**	**Description**
Fact. Password [Press P] XXXXX			DO NOT OPERATE, press "P"

10 Order specifications

When ordering MGC-1 current and voltage measuring input range and options must be specified.

Order specification of MGC-1 consists of the following:

MGC-1 - X - Y - Z, where V, X, Y and Z is as follows:

X determines the measuring voltage input:
- -1 means voltage transformer 110VAC or 100VAC input
- -4 means up to 450VAC direct voltage input

Y determines the current trafo secondary:
- -1 means current trafo 1A secondary
- -5 means current trafo 5A secondary

Z determines the options:
- -A means voltage control/Cosφ control/VAR control
- -B1 means analog speed governor output
- -B2 means analog AVR output
- -B3 means analog speed governor and AVR output
- -C means analog transducer outputs (multitransducer)
- -D1 means value reading through RS232 Siemens 3964 protocol
- -D2 means value reading through RS485 Modbus RTU
- -D4 means control and value reading through RS485 Modbus RTU
- -E means dφ /dt protection (vector jump)
- -F means df/dt protection (frequency deviation or rate of change of frequency)
- -H means power maximum relay output
- -K0 means 12V DC power supply
- -K1 means 48V DC power supply
- -K2 means 110V DC power supply
- -K3 means 220V DC power supply
- -L means that the front is IP54 protected

11 Appendixes

11.1 Appendix 1 Measuring principle

MGC-1 is based on a modern digital processing platform where all current and voltage signals are digitally sampled and all measured values are calculated from the sampled signals. This ensures a very accurate measuring system that also measures harmonics in voltage, current and power. MGC-1 will measure up till 500Hz (10th harmonic of a 50Hz system). From 500Hz to 2600Hz (52nd harmonic of a 50Hz system) MGC-1 will measure the harmonics in the signal with slightly reduced accuracy. The digital measuring principle will also give a faster response compared to conventional analog systems. All measuring signals will be updated for every period (20ms@50Hz) and it is therefore possible to have responses from protective relays down to 30 ms (1 measuring period + output reaction time).

All voltages and currents are calculated as true RMS values by the formula:

$$U_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}, I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$$

Where u_n and i_n are the sampled values and N is the number of samples during one period of the input signal. And in the same way the active power P is defined as:

$$P = \sum_{n=1}^{N} \frac{u_n \cdot i_n}{N}$$

Where N is the number of samples during the latest period of the voltage input signal.

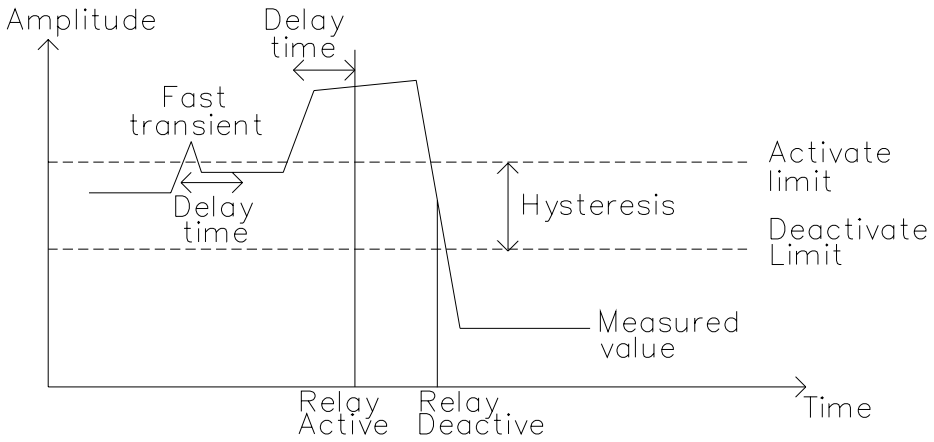
cos(φ) is measured directly as cosinus to the measured angle between current and voltage. Current and voltage signals are effectively filtered before cos(φ) is measured, so the measured angle is only affected by the fundamental signal.

Reactive power is measured on basis of sin(φ) measurement, phase to phase voltage and generator current. Sin(φ) is only measured for phase 1 and the total reactive power is therefore measured as √3 times the reacive power measured in phase 1.

$$Q = \sqrt{3} \cdot U_{RMS} \cdot I_{RMS} \cdot \sin\varphi$$

11.2 Appendix 2 Measuring principle

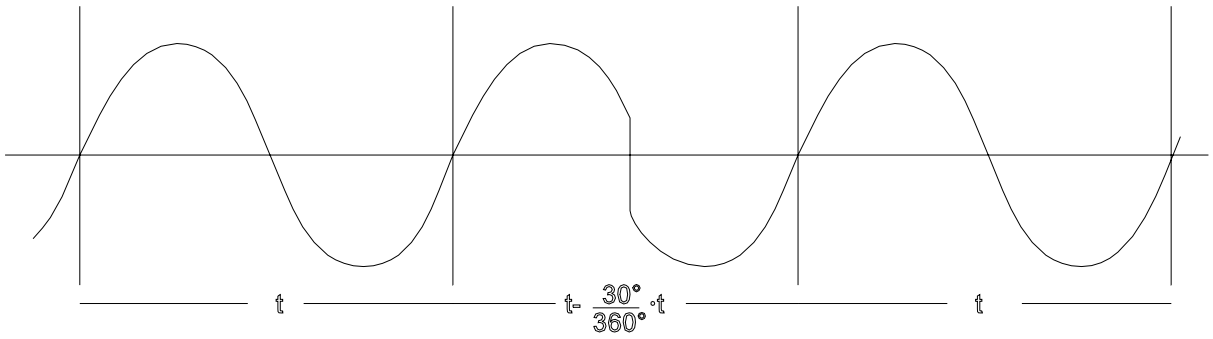
All generator protective functions in MGC-1 operate by the same principle. The signals are measured as described above and these measurements are handled by a software comparator with a timer. From programming of the protectionlimit and delay it can be seen that the structure of this comparator and timer is identical on all protective functions. The function of the comparator and timer is the one of a definite time relay. This means that the time delay before trip is not affected by how much the level is exceeded. When a relays function is measuring on 3-phase values (e.g. 3 phase current relay) the relay will react on the highest measured value of the 3 phases. The relay operating principle is illustrated in the figure below in which a fast transient that will not cause any trips is shown together with a fault that causes a trip. The figure also illustrates the hysteresis setting that sets the change in measured value needed before the relay deactivates after a trip.



The protective relays can be programmed either to be self-resetting when a fault disappears (shown above) or holding the output signal until the fault is acknowledged through push-button or external acknowledge signal.

11.3 Appendix 3 vector jump protective relaying operating principle

The vector jump is a change in the phase of a voltage which causes a discontinuous voltage jump and a sudden change in period length that lasts for only one period. A vector jump can e.g. be caused by a big load change ona generator. An example of a voltage with a vector jump is shown in the figure below:



The vector jump is detected by comparing the measured period lenght t_N with a mean of earlier period lengths. The difference in period length is expressed in degrees with respect

to the mean of earlier period lengths where the mean of period lengths is taken from t_{N-3} to t_{N-10} to make sure that the mean is not disturbed by the vector jump:

$$vectorjump = \frac{t_i - \sum_{i=I-3}^{I-10} \frac{t_i}{8}}{\sum_{i=I-3}^{I-10} \frac{t_i}{8}} \cdot 360°$$

The vector jump relay can be adjusted to react only on vector jump that occurs synchronous on all 3 phases or to react both on synchronous vector jumps and vector jumps that only occurs in 1 phases. The synchronous vector jump detection is more noise immune than the singel phase vector jump detection.

11.4 Appendix 4 df/dt (ROCOF) protective relaying operating principle

The df/dt protective relay or rate of change of frequency relay measures the frequency deviation over timer as defined by the formula below:

$$\frac{df}{dt} = \left(f_{NEW} - f_{OLD}\right) \cdot f_{NEW}$$

where f_{NEW} is the latest calculated frequency and f_{OLD} is the latest calculated frequency by one. To recognise a df/dt the frequency gradient must be present in all 3 phases.

Errors and changes excepted.